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THE PROCEEDINGS

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UNITED STATES NAVAL INSTITUTE.

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HONORABLE MENTION, 1898.

MOTTO: "Fire is everything."—*Napoleon.*

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

TARGET PRACTICE AND THE TRAINING OF GUN CAPTAINS.

By Ensign R. H. JACKSON, U. S. Navy.

In the historical accounts of the brilliant success attending our ships in the naval fights of 1776 and 1812 mention is frequently made of the deadly aim with which the batteries of the American vessels were directed against the hulls of their antagonists, sweeping their decks and destroying entire gun's crews in a single broadside, while the shot of the enemy often flew high and wild, doing only slight damage to the rigging.

In the fight between the Constitution and Guerriere we find the following description: "The gunnery of the Guerriere was very poor, while that of the Constitution was excellent. During the time the ships were yard-arm and yard-arm no less than 30 shots took effect in the side of the Guerriere, while the Constitution was not once hulled."

In the fight between the Wasp and the Frolic the contest was

mainly one of gunnery and was decided by the greatly superior judgment and accuracy with which the Americans fired. Another writer criticises this fight as follows: "The American fire showed itself to be as rapid as it was accurate. On occasions when the roughness of the sea would seem to render all aim excessively uncertain, the effects of their artillery were not less murderous than under more advantageous conditions." After 40 minutes the man at the wheel and three officers remained to surrender.

In the United States-Macedonian fight, the captain of the latter, finding himself worsted at long range, endeavored to close on his antagonist. In this he was not successful, as the skilled gunners on the "States" soon so damaged the Macedonian that she fell astern and to leeward. The "States" kept a position for raking fire on the Macedonian at long range till the latter was hopelessly disabled, then going about, she stood under the Macedonian's stern, and the latter struck her colors.

Witness on the other hand, in the case of the Chesapeake-Shannon fight, the folly of attempting with a raw untrained crew to secure a victory when matched against the Shannon, exercised in target practice for weeks, well disciplined and especially prepared for this fight.

Lawrence's defeat was a foregone conclusion and his gallantry and glorious death a needless sacrifice.

The following gives a clear idea of the state of discipline and efficiency of the Shannon's crew: "There was another point in which the generality of British crews, as compared with any one American crew, were miserably deficient, that is skill in the art of gunnery. While the American seamen were constantly firing at marks, the British seamen, except in particular cases, scarcely did so once in a year, and some ships could be named on board which not a shot had been fired in this way for upwards of three years. Many captains never put a shot in the guns till an enemy appeared; they employed the leisure time of the men in handling the sails and decorating the ship. Not so on the Shannon. Every day for about an hour and a half in the forenoon, when not prevented by chase or state of the weather, the men were exercised at training the guns. Twice a week the men fired at targets, both with great guns and musketry, and Captain Broke, as an additional stimulus beyond the emulation excited, gave a pound of tobacco to every man that put a shot through the bull's eye."

It would be a grave error to suppose that seamanship played little or no part in these engagements. Its function was a very important one, viz. to bring to bear all the guns, and keep them constantly in action, while keeping the ship in such a position that few or none of the enemy's guns could be worked to advantage. To this end the ship was always manœuvred to obtain a position for raking fire. But that victory should crown this manœuvre with success the crew must be trained to the highest state of efficiency, that a hot and deadly fire might be poured upon the enemy during the precious moments that the ship could hold this position.

There was no great difference between the ships of the leading maritime powers in those days. French, English, Spanish and Americans had all turned out fine specimens of naval architecture. So it is to-day. The five or six leading naval powers have battleships and cruisers, torpedo-boats and destroyers, that are nearly evenly matched, sometimes built by the same contractors for different nations.

Those were the days of wooden hulls and 18-pounders; now there is 18 inches of steel armor and a shell weighing half a ton; but no nation can rightfully claim superiority in material to-day with any better reason than one hundred years ago.

No sooner has one power succeeded in perfecting or increasing the efficiency of an armor plate, a gun, or a torpedo, than a similar advance is made by each of the others.

What then will decide the victory of to-morrow? Not the material, for that is evenly matched, but the personnel.

What essential must the personnel possess above all others? They must be well disciplined and trained, to the end that the maximum rapidity of fire attainable with the greatest accuracy may be maintained in the presence of the enemy. The one object, the destruction of the enemy, must be achieved, and that result can only be achieved by "the man behind the gun."

Can we now claim superiority in gunnery over the navies of the world? Have we reached the highest possible state of efficiency in training our men? Have we a carefully selected and trained body of men for this purpose?

A most important step in this direction, and one which the service has long endeavored to make, was recently accomplished. A gunnery ship was detailed for the purpose of training specially

selected men to become expert marksmen with great guns. One hundred men were selected by commanding officers of vessels in the North Atlantic squadron and sent to the Amphitrite for instruction.

As soon as these men have become expert they will be drafted for general service and another detail of men selected for gunnery training.

What are the qualifications that these men should possess, what training receive, and what position hold in general service?

A gun's crew should be selected and trained to serve the gun with the greatest rapidity and fire it as rapidly as is consistent with accuracy.

Observe a turret crew at exercise firing at a target, and note the qualities most needed in the leading men. There is a man, the gun pointer, stationed in the sighting hood, sometimes one for each gun, sometimes one for each turret; he has his eye at the telescope and directs his entire attention to the target. His control of the gun varies in different ships. He always fires the gun; he also usually either elevates or trains it, sometimes he does all of these. His is the master mind, however, that controls the fire. The rest of the crew prepare the gun for his use. When the gun is on the target *he* fires; *his* judgment alone comes into play. He co-ordinates all the variables at work.

What are the requirements to fill this billet? Just one. He must be a good shot. He must hit the target. There is only one way to tell a good marksman, and that is to give him a rifle. If he cannot make a good score with a rifle on shore he certainly never will on board ship with the target dancing all over the field of the telescope. It does not follow that because he has made a good score on shore that he will be a successful gun pointer; he may be too slow in his movements, or be confused by the multiplicity of his duties when trying to get elevation and train to coincide on the target. But if a good gun pointer *can* be obtained it must be from this class.

Consider next the remainder of the turret crew when the gun pointer has delivered his successful shot. Every effort is now made to clean, reload, prime and report the gun ready to be again fired by the gun pointer. To this end the gun captain, while performing certain duties himself, is especially responsible that each man in the crew performs his duties in turn, quickly

and thoroughly, and that no time be lost waiting for the next step in loading; he must then be quick, intelligent, with good command of men and resourceful, so that he may get the best results from the crew, and that any slight mishap may be at once remedied without delay.

Here then are two types of men, having entirely distinct functions to perform and with probably markedly different characteristics—the gun pointer to fire the gun and the gun captain to serve it.

How then are they to be selected and trained for these distinct duties?

Take the one hundred men recently drafted to the gunnery ship. As these men have not been selected on account of any special aptitude as marksmen, the first step is to pick out the best marksmen. For this purpose a series of competitions with 6 mm. Lee rifle should be held on shore. At the end of two weeks' or a month's steady practice the records should be made out in order of merit, and the first half be promoted to acting gun pointers, and exercised in sub-calibre practice at the secondary and auxiliary battery. The remainder to be trained for gun captains. This would consist in instructing them in the duties of all the numbers in a turret crew, the manipulation of all machinery in connection with the turret and the service of the gun. At the end of two weeks' or a month's practice the gun pointers should be again arranged in order of merit and a certain number of them (½) be selected for turret gun pointers, and be drilled in sub-calibre practice with the turret guns. All of this practice to be stationary.

The men would now be arranged in order of merit for turret gun pointers, secondary and auxiliary gun pointers, and gun captains.

Men failing to qualify for gun captains to be returned to general service in the rating in which they were received.

Having now selected and sorted out the men, there remains only practice and plenty of it to perfect their marksmanship.

The practice should be progressive and instructive. For a month daily practice should be held, firing at a target placed at a variable and gradually increasing distance from the ship. The target should be a large one, that not only perfect shots but fairly good ones will score. A bluff or steep hillside selected on shore, with an Army B target placed at a conspicuous point on this,

would answer. A rectangle sixty feet long and ten feet high could be laid off, with B target as central point, and an observer placed near by under cover to plot the shots. Shell without charge or fuze should be selected for this practice. As the crews become more expert at close range the anchorage should be shifted till a range of 800 to 1000 yards is reached. The men having obtained proficiency in this practice, the ship should get underway, and steam past the target at ranges varying from 500 to 1000 yards, at a speed of nine knots. Special attention ought to be paid to the position of the target in the field of the telescope that gives the best results, and also when using open sights how much to hold abaft the target to make a hit.

Finally, a target to be anchored off shore, and the ship to steam by, firing first at the short ranges of 500 to 1000 yards and using sub-calibre ammunition; then running by the target at ranges from 1000 to 2000 yards and firing service charges.

Competitive practice to be held at the end of the third month, under as similar conditions as possible for each man, and the men marked and rated according to their merit. The men who had become proficient turret gun pointers to be given acting appointments as gun pointers 1st or 2nd class according to merit. The gun pointer 1st class to be stationed in 10-in. turrets and above; the gun pointer 2nd class in 8-in. turrets.

The men who had become proficient as gun pointers at the auxiliary battery to be given acting appointments as gun pointers 3rd class, a few of the most proficient marksmen being given acting appointments as gun pointers 2nd class.

To hold an acting appointment as gun pointer a man must qualify as first class marksman under the conditions now laid down by the Bureau of Navigation, his score, however, to be the average of three sets of firing. After having held acting appointments two years, upon the recommendation of the commanding officer, the Department to issue a permanent appointment.

The pay of gun pointers to be as follows: 1st class, $50 per month; 2nd class, $40 per month; 3rd class, $30 per month.

At the annual record practice each ship to give prizes for the highest scores in each class as follows: Gun pointers 1st class, $100; 2nd class, $50; 3rd class, $25, for each four guns. Provided that no prize be given where the gun pointer averages less than 60.

Coxswains for boats to be selected, preferably, from the gun pointers, though any man possessing the qualifications for coxswain may be appointed. A man holding an appointment as coxswain to receive $5.00 per month in addition to the pay of his former rating, as is now done for coxswains of steam launches, and the seamen acting as captain of the hold.

Gun captains in charge of 10-inch turrets and larger calibre to be rated gun captain 1st class, and those in charge of 8-inch turrets, gun captains 2nd class. As these men possess the qualifications of men now holding the rate of boatswain's mate, they would simply replace the boatswain's mates in the ship's complement so far as they extended. In many instances this organization now exists on board ship; the boatswain's mate is also the gun captain of the turret crew, and controls the same men at all times, whether at quarters or while carrying on the routine work of the ship; the routine work being carried on by divisions, the gun's crew being the unit of organization. These men to receive acting appointments in their ratings, and to be made permanent as now prescribed by Navy regulations for other acting appointments. Their pay to be that recently assigned to gun captains 1st and 2nd class by the Bureau of Navigation.

No gun captain need be stationed at the auxiliary and secondary batteries, as the duties of the men at these guns are so simple that they can be easily and quickly carried out without the need of a petty officer specially trained. There is always a gunner's mate in the division who can remedy any slight mishap to the lock, breech-plug, etc., that may occur. A gun pointer to fire the gun being the only specially trained man in the crew.

A resume of the plan suggested is the following:

(1) As the gun's crew is now the essential, and the ship is organized by divisions, replace the rating of boatswain's mate by that of gun captain.

(a) Gun captains 1st class take charge of 10-inch turrets and above.

(b) Gun captains 2nd class take charge of 8-inch turrets.

(c) Coxswains take charge of guns of 6-inch and lesser calibre.

(2) Train expert marksmen, this to be their sole requisite, and assign them to guns according to their value.

Station gun pointers 1st class at 10-inch and above.

Station gun pointers 2nd class at 8-inch.

Station gun pointers 3rd class at 6-inch and lesser.

Give coxswains $5.00 per month in addition to the pay in their rating while so acting. Select them preferably from gun pointers where suitable men can be obtained.

(1) *The cost.*—The Department has already established the rate of pay here adopted for gun captains, and has not decided how many of them will be appointed to a ship.

If a gun captain is allowed for every gun or pair of guns in the main battery, and no reduction be made in the boatswain's mate's class, the number of petty officers would be very greatly increased. We have now a very liberal complement of petty officers. In many ships over 50 per cent of the deck force are petty officers. So, recognizing that there are going to be gun captains on board ship, this scheme would be economical.

In regard to the prizes awarded, the sum may appear large. Consider what the prizes would be on the Iowa, which would be the largest awarded: $175 a year for men who can deliver a fatal blow to the enemy. That ship is at present authorized to pay $250 a quarter, or $1000 annually, for *small-arm* target practice, which of itself would be of no value in a naval engagement.

One constantly reads editorials, hears speeches and listens to arguments to show that the Navy is the means of insuring the peace and commercial prosperity of the country. This is true, and in proportion to the values insured it is very cheap. Go one step further and one finds that skill and excellence in gunnery is the insurance for the very existence of a navy; for a failure or weakness at this point would cause the disappearance of the navy in the first fleet action; its destruction by the superior fire of the enemy. Is not a liberal expenditure of ammunition and frequent target practice a cheap insurance when its value in men and material is considered?

(2) *Efficiency.*—The increased efficiency of the ship in gunnery cannot be doubted, but would the discipline and seamanship be as good?

Gun captains.—In the case of gun captains 1st and 2nd class the billets would be filled by men now holding boatswain's mate's appointments.

Coxswains.—It is held as a vital point that there must be a

skilled marksman at each gun. If among these marksmen men can be found with the qualifications required for coxswains, appoint them to that billet and pay them for their work. It is not probable that there would be any falling off in the efficiency of this class. Many of them now are unsatisfactory. They are faithful scrubbers of paint-work and of their boats, but lacking in seamanship and control of their crews. Nor is it to be expected that a man would willingly undertake the extra work and drudgery of coxswain without additional pay.

The following table gives the complement of petty officers now allowed on certain types of ships, and the number required by this scheme.

Rates Old and New.	Iowa and Indiana.		New York and Class.		Puritan and Class.		Raleigh and Class.		Marblehead and Class.	
Ch. B. M.....	1		1		1		1		1	
Ch. G. C.....		1		1		1		1		1
B. M., 1st c..	4		4		2		2		1	
G. C., " ..		3		1		3		1		1
G. P., " ..		2		4		2		0		0
B. M., 2nd c.	4		4		2		4		4	2
G. C., " .		4		2		0		2		2
G. P., " .		8		2		0		4		
Cox.....	12		12		4		8		6	
G. C., 3rd c...		4		12		3		7		6
Totals.....	21	22	21	22	9	9	15	15	12	12

No mention has been made of a chief gun captain, but from the gun captains 1st class there could be gradually selected the most deserving men to hold the senior position of chief gun captain. He might have certain stores in his custody, similar to the present chief boatswain's mate, but this seems unnecessary. With this exception his duties would be those of the senior gun captain 1st class.

In the assignment of the complement to cruisers and gunboats it is noted that the rule first mentioned would give only 2nd class gun captains and gun pointers to the New York and her

class, and only 3rd class gun pointers to smaller cruisers and gunboats. As it is important that there should be several most excellent "all-round" men in every crew, the complement is accordingly modified.

As it is held that the training for gun pointer of a turret gun is quite different from that for a gun of the auxiliary battery, the gun pointer 2nd class sent to cruisers and gunboats should be those that had by special merit been promoted from 3rd class gun pointers, and not those holding ratings as gun pointers 2nd class at turret guns.

Target practice.—A new order of target practice has been issued, most liberal in its allowance of ammunition, requiring that target practice shall be held seven times a year, and earnestly recommending that every effort be made to develop the accuracy and rapidity of fire on board ship. If the spirit of this order be carried out the improvement in target practice will surely be most marked.

The North Atlantic squadron has recently had a very extensive series of exercises at target firing, but the results have not yet been published. One of the difficulties attending target practice is lack of suitable firing ground and target. A ship spends more time making preparations laying out targets, boats, etc., than she does in firing her battery. Regular practice grounds, with permanent targets, located as conveniently as possible, would aid greatly in carrying out the practice. Suitable ranges can be obtained in Gardner's Bay, off the Southern drill ground, and at Port Royal.

For the great gun range use the gunnery triangle as in present practice, and moor at the apex of the triangle a large sea buoy; a heavy spar buoy would be most suitable. Mount on top of this a conspicuous cage and mark it with a bell or whistle, that it may be an aid, and not a menace, to navigation. At the extremities of the base of this place a marker's buoy, to assist the ship in running over the course and to indicate the point at which she would drop her boats when they are to be used by observers.

The target to be this cage, as already stated; but when opportunity offers, place the regulation target, or the Naval Academy target, just in front of it; or better still, lay out a large target 50 or 60 feet long and 10 feet high, supported at the middle

point by this buoy, and an additional buoy each side of the cage, 100 feet distant, and parallel to the base line. These two buoys would be useful in laying out a large target, and when no target was sent out from the ship a vessel could run along the base line, and with an observer in the top could get a very fair idea of the fall of the shots by having these three points on which to check the splash of the shell.

When the only preliminary to target practice consists in spreading fires and steaming out to the firing ground, it is probable that ships would be able to get out for practice much oftener than now. A vessel could then anchor on the firing ground and spend several days at sub-calibre practice, without spending half of each day getting her targets in position.

Small-arm ranges can also be established at the points named. Gardner's Bay has been in use for years, and the Maine is laying out a range at Port Royal. The Cape Henry beach proved very satisfactory for the practice of the Puritan, but the landing would be bad with northwesterly winds and rough weather. No doubt a range can be found at Yorktown that will prove safe, though the first range selected there was dangerous.

The small arm range should be as convenient as possible, both as regards distance and also facility for landing, etc. So that not only may the regular allowance be fired each quarter, but also rifle teams be organized on the different ships and competitive firing be held. Men belonging to these teams—and they ought to be the gun pointers mainly—might also be given practice firing at a barrel or box thrown overboard when steaming along at sea. Sub-calibre practice at sea could also be held in the same way, using the after guns and shifting the crews.

The practice on board ship with the 0.22-cal. rifle has proved quite beneficial when it has been much used in conjunction with sighting drill, especially where the drill has been made progressive. The man being exercised at sighting drill, making triangles, till he has reduced his error to a small triangle; then fire at a target with a 0.22-cal. rifle *at rest* till he makes good scores; finally give him plenty of practice without a rest, and he will make a good score on his quarterly practice.

A suitable place can be found on board ship where the target for the 0.22-cal. rifle can be set up, and crew fire, as one of the regular afternoon drills.

In order to ascertain the names of the best shots with great guns at present in the service, and get their average proficiency, the records of target practice for the last year have been analyzed.

Some of the results are of interest. The main battery alone is considered.

Total number of strings of shots fired, 628; total number of gun captains firing, 395, so that each gun captain fired 1½ strings. If both moving and stationary practice were held each quarter each man would have fired 8 strings, and there would have been 78 gun captains exercised each quarter and becoming expert marksmen. The records show that nearly 400 gun captains fired and that 23 per cent failed to make any score whatever.

Only 50 men of the 400 fired at target practice more than twice during the year; only 4 men fired at the target 5 times during the year.

Nor do the scores show a good average for different quarters. A man would make 75 one quarter and 16 the next; or 120 and then 25.

The total average was 42; average for men firing 2 or more times, 44; average for men firing 3 or more times, 57.

One word in conclusion regarding an incorrect term applied to a rating that has grown up in the service, and that needs to be changed if there are to be gun pointers and gun captains. The seaman gunner is a man who has received a special training in electrical appliances and ordnance. Would not "ordnance seaman" or "seaman electrician" be a better and less confusing term, if there is need for any title to indicate that men have taken this course? The letter "O" on the records should suffice.

NOTE.—The authorities quoted are William James, J. de la Graviere and Theodore Roosevelt.

DISCUSSION.

Lieutenant A. A. ACKERMAN, U. S. N.—In the main, I agree so well with the essayist that I am inclined to criticise the modest limits which he has set to his treatment of the subject rather than anything which he has said.

On our battleships, where but one officer—including cadets—is allotted to every twenty-five men in the gun divisions, trained gun pointers are invaluable. The divisional officer's attention must frequently be drawn from the correction of ranges, etc., to the service of a particular gun, or to the combating and removal of difficulties certain to occur in many forms within the sphere of his responsibility. In the turrets a gun pointer requires peculiar training; there is a discipline of nerves and heart as well as of the eye, and without it he will, on occasion, lack the fine self-control necessary to prevent the very powers subject to his hand from causing disaster.

The introduction of the sighting telescope has practically eliminated the personal equation of the gun pointer, while the substitution of the more sensitive and easily controlled electric motors for other machines, as well as the balancing of the turrets, has made refined adjustments and pointing of heavy turrets possible. These are improvements which can be best appreciated by those who have labored amidst the groaning, lurching complications of the older types.

It is remarkable, considering the purposes for which the ships and guns were built and given us, how difficult it is to obtain frequent target practice. It must be admitted that the Department's Circular of July 22, 1897, sets forth a most wise and necessary plan for making our gun-fire truly formidable; for battles are won neither by armor nor caliber nor number of guns, alone or combined. And yet ship life is so cumbered with matters having no relation to preparation for war, that it is doubted if many ships in the navy have thus far been able to carry out the prescribed routine.

Even when the obstructions to target practice are overcome, the conditions are often such as to require haste. This is bad, for though it is difficult to explain, it is still a fact that men may drill satisfactorily every day with dummy shell and charges, and yet, when the rare occasion comes for handling the real, there is a nervous excitement which if unconsidered will surely lead to bungling and perhaps disaster.

Much has been said concerning "the man behind the gun" and his share in winning a glorious victory. He can be relied upon to do his very best, and his officers should and will do their best to render him efficient and direct his efforts to the best advantage. It seems, though, that a target practice which stops with the testing of the merits of gun pointers and the training of guns' crews is not all that is required. There is much more to be learned and practiced; much, without which the man behind the gun will become a helpless victim, and without which our officers would become mere pedants rather than trained fighters of their

ships and batteries. The conditions of target practice should as nearly as possible resemble those of actual battle,—not only for the man behind the gun, but for every officer and man, no matter what his duties. If this was done it would soon bring to a settlement many of the disputations as to the control of gun fire, determination of range, best methods of communication, etc., etc. It is the only way in which frequent and thorough trials of the ship's efficiency and condition for battle may be made.

There is just as much reason why a conning tower, if necessary at all, should be large enough for its purposes as a turret, only the service of the guns in the latter seems to be more clearly defined and insisted upon than the requirements of the occupants of the conning tower. What chance has a commanding officer to navigate his ship on soundings through the peepholes of a conning tower? It would be interesting to learn something of the views of those who have merely tried to consult a chart in the crowded space. Is it not a relic of the days of brute force that we must rely on massive indicators and three-foot wheels in an overcrowded conning tower to control the submissive giants below of steam, hydraulics and electricity? A valve or switch the size of a door-knob would do as well, and yet certain of our ships are given light draft so that they may take advantage of shoals and inshore passages to carry on the fight. Who has not heard the Central Station declared a fraud? And yet the idea is correct if it was only carried out. Now, however, we have a tiny, superheated space crowded with delicate instruments and means of communication; while the *armored tube*, instead of being at least three feet in diameter, of thin plate above the conning tower, and leading straight to the upper top—the ideal post for navigator and range observers, if not signalmen—is barely a foot in diameter, and choked with wires and tubes intended to increase the labors of the already overburdened captain. Sometimes these wires go wrong in the tube and then the amazing wonder is that they are ever got right again. The captain and his ship would be far better off if the conning tower was stripped bare, leaving the empty tube through which he could express his wishes to helmsman and other assistants in the central station below. All this could be easily arranged by making a small raid on that part of the coal supply and space which is *not* "normal" and which it is not intended should be carried in battle. It may be added that in this way our present battleships may be provided with submerged torpedo tubes without otherwise interfering with their efficiency in battle.

And now about some of the difficulties which will be met in action and which are often carefully avoided in target practice. The estimation of range through the peephole of a turret sight hood is difficult; and even if the smoke of your own and the enemy's guns obligingly removes itself, to locate the fall of your shot is more difficult, and yet the turret gun pointer must himself compensate for the variable rotation of his turret, roll of the ship, its possible change of direction, and the wind, as superimposed on the combined effect of the speeds of the two ships. It would seem that at least he should be assisted by a steady course, uniform speed, and the coaching of an outside observer.

The flat trajectories resulting from the high velocities obtained with smokeless powder and high-powered guns make moderate errors in range of comparatively little importance, and it has been proposed to avoid the difficulties of range finding by rushing in to close quarters where every shot would tell. So, the essayist tells us, was the "Macedonian" fought—until she struck. It is mortifying to admit, even for an instant, that we lack the superior trained intelligence, so long claimed for us, that will enable us to defeat a less skillful antagonist at a moderate range with the least injury to ourselves. For that matter it does not follow that we would be able to select our own point of attack; and even then, would it be wise to go inside of torpedo range?

How then is the range to be determined? No matter how obscured the horizon and water line of the enemy may be by smoke or fog, there must be frequent intervals when parts of his smokestacks or masts will be at least faintly visible, and then we would wish for a simpler, even less accurate, finder than that of Lt. Fiske, but preferably of the same type. For in battle the only base that can be absolutely relied upon is one laid down on our own ship; and if but a single arbitrary point outside is observed, the chance of continuous observations is much more certain. In default of such a method, preparations should be made in every way possible by stadimeters, Buckner's method, etc. It has been proposed to determine the range by means of sighting shots from small guns, but consider what that entails. In order to avoid confusing the fall of the trial shot with others, fragments of bursting shell, etc., the entire battery must cease firing, even the enemy must be clear of smoke; and before a successful shot is fired and the range transmitted, the relative position of the ships may have changed, again necessitating a further delay.

The aiming drills are most important; unfortunately our progress is glacier-like, and drill routines are apt to retain all the old characteristic fissures and hummocks while making new ones; they carry their past with them. And so our energies are often wasted in the effort to teach denationalized nomads to signal in English, while sub-caliber practice would be easily comprehended and more to the point.

Lieutenant WILLIAM G. CUTLER, U. S. N.,—Mr. Jackson's motto is well chosen—"Fire is everything." To it everything on board a warship should be subordinated. If on arrival within range of an enemy, we cannot hit him, all our outlay is in vain and our ships are failures. Their one object of existence is to carry their batteries within gun range of the enemy. This accomplished, and maintained through the skill of the captain and the faithful performance of duty of the engineer, the issue rests with the gun pointers. On them the captain is absolutely dependent for success, and no matter how skilfully he may handle his vessel in bringing his guns to bear to the best advantage, all is in vain unless hits can be scored.

Mr. Jackson asks the three following pertinent questions: Can we now claim superiority in gunnery over the navies of the world?

Have we reached the highest possible state of efficiency in training our men?

Have we a carefully selected and trained body of men for this purpose?

To each of these questions the American naval officer must regretfully answer—no!

In this vital matter I believe that we are sadly deficient; but I am hopeful that the present war with Spain will give us an object-lesson in the all-importance of accurate gun fire that we shall never forget, and that the future will see our officers making this feature the object of their professional lives.

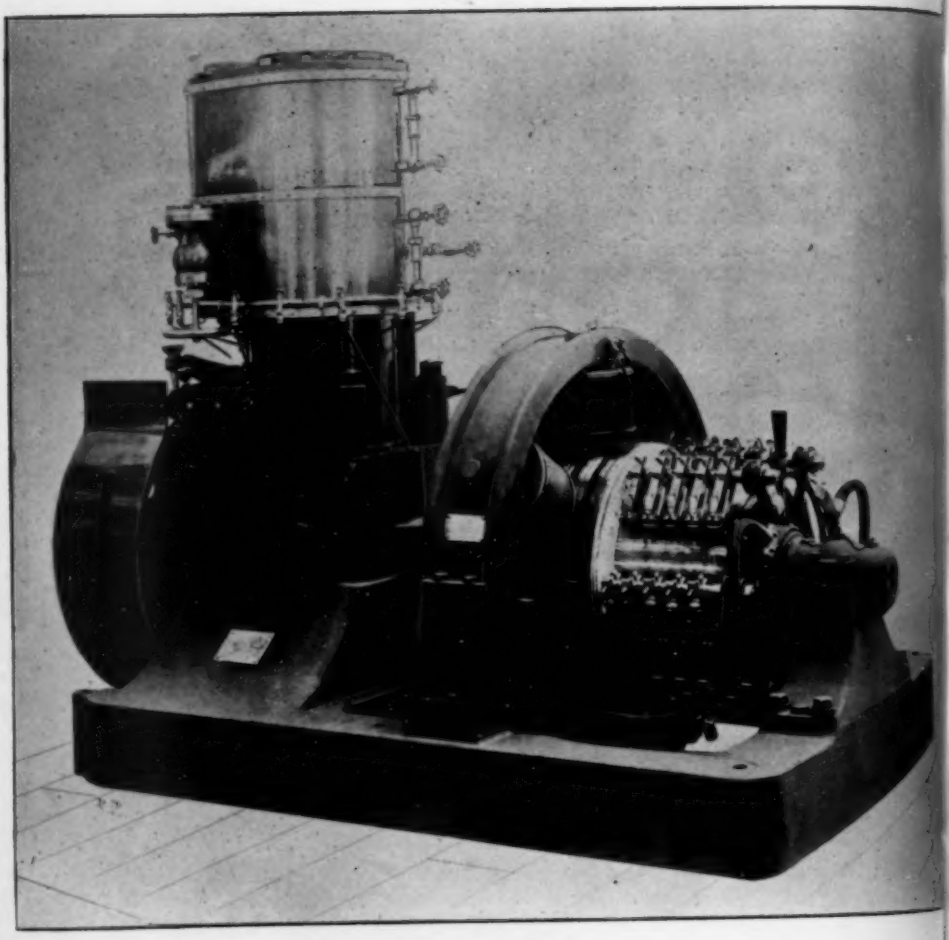
The Spanish fire both afloat and on shore has up to date (July 6th) been so excessively bad that relatively we shine by contrast. In the present war this is very satisfactory, but we are most fortunate in our adversary.

In striving for rapidity of fire let us not overlook the infinitely more important element of accuracy.

As Mr. Jackson says, the Amphitrite in her quality as gunnery training ship was a most important step. In my judgment, however, she is not the type of ship best adapted to this purpose. I believe that an absolute official line should be drawn at the calibre of gun to be fired by bluejackets. This line I would draw at the 8-in. gun. All guns of and below this calibre should be fired by bluejackets. All higher calibres by officers. The bluejackets I would put through such a course of training as Mr. Jackson suggests on board a suitable training ship. For such a training ship the Chicago would be ideal. Fitting her with every calibre of gun from 8-in. down, in the hands of enthusiastic officers she could do a great work. Her graduates, distributed throughout the service, and rated and paid according to their importance in action, would constitute a most important force in time of war. Take the Boston at Manila Bay; who was the more important in the moment of action, the machinist or yeoman, who can be gotten by the hundred, or the gun pointer of her forward 8-in. gun? *Men must be rated and paid according to their value at the guns in action.*

For the turret guns let us take the intelligent, highly educated Naval Academy graduate. Let us make more of a feature of target practice among the cadets, and put those of each class *whom nature has qualified* as natural gun pointers through a thorough practical course after graduation. The letters T. O. (Turret Officer) or their equivalent might well be placed in the Navy Register after the names of those who have qualified as such. This would be a distinction which all would covet.

Mr. Jackson's paper is most opportune, and I trust that, accompanied as it is by the object-lessons of the present war, it may do much to stimulate interest and hope in this all-important subject.



FRONTISPIECE.

50-K.W. Tandem-Compound Set for Kearsarge and Kentucky.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

DISEASES OF ELECTRICAL INSTALLATIONS IN THE NAVY.
THEIR CAUSES AND REMEDIES.

By Lieutenant B. T. WALLING, U. S. N.

(From lectures delivered before the U. S. Naval War College.)

INTRODUCTORY.

The entire scheme and system of our electrical installations have been, from the nature of the case, progressive, and we may confidently say have shown a steady march toward improvement in details and efficiency. Ever since the introduction of electricity on board ship there has been a constantly increasing demand for this form of energy, and it is to be anticipated that much larger demands are shortly to be made upon the adoption of electrical power for turning guns as well as turrets, for operating auxiliaries, for all purposes, in short, which will minimize the present objectionable heat of long lines of steam piping, the annoying leaks of hydraulic apparatus and the excessive weights of pneumatic appliances; to this may be added that a break in a steam or hydraulic pipe could easily drive every one from the compartment.

As a simple matter of weight, the installation of any particular device is very evenly balanced between the electrical, hydraulic or steam, but when the proposed three-wire system is installed, at a saving of motor weight and 67 per cent. of copper in the leads, electricity will be far in the lead in that respect also.

Perhaps the greatest weight of argument in favor of electricity is the ready change from electrical to hand control in emergency, and the facility of maintaining and repairing the leads.

Conservatives declare that we should be slow in making such a radical change, that too many eggs are going into the same basket, that electrical science is still experimental and in its infancy, and that a stalled gun or turret in action would mean destruction.

To these we can confidently answer that the question of applicability to gun and turret use has been settled by the trolley long ago. Minute control of the power to be applied to turret or gun has been discovered in separately exciting the fields of both dynamo and motor; irregularities of turret load is a mechanical question of balance applying with equal force to any system of power.

The proof of the ready perfect control of electrical power as applied to turrets was instanced in the recent trials made on the Brooklyn at Cramp's shipyard, when the turret was successfully started and stopped *thirty-seven times in a peripheral distance of one inch in the same direction;* this result easily challenges competition; reports from trials at sea are that the turrets were handled with ease.

Our naval electrical history began in 1871 with a small Farmer's series dynamo whose armature was revolved by a hand crank and whose output did not exceed 100 to 150 watts, which then sufficed for all needs, but whose total energy would in this day be consumed by a single 32-C. P. lamp.

In 1897 the Iowa and Alabama require an output of 96,000 watts, supplied by four steam-driven compound generators of a capacity of twenty-four kilowatts each in the one case, and three of thirty-two kilowatts capacity each in the other. The Brooklyn is furnished with a total capacity of 150,000 watts; the Kearsarge and Kentucky will have 350,000 watts distributed between two double sets (100 K. W.) in the lower dynamo room and three single sets (50 K. W.) in the upper room in each ship. (See frontispiece.)

Two-thirds of this energy is for use as power, and in line with the increased and increasing demands has come the necessity for increased voltage in order to reduce wire size,* motor

* The energy of a circuit is equal to the product of the voltage (electromotive force) and current, that is,

$$\text{Energy (Work)} = CE.$$

Evidently if E is doubled we halve C, and the wire size is proportionately decreased.

dimension, weight and cost. The same demands have necessitated a change in the type of our dynamos from the "smooth body" to the "slotted core" design, by reason of superior induction and less weight and cost, and this in turn has indicated automatic circuit breakers to operate at either of the failure of the line voltage or overload. The "smooth body" armature has served us faithfully and well, but has been forced to yield to superior considerations.

The voltage selected for the three-wire system is 160 volts, thus preserving a pressure of 80 volts at the lamps. It is often asked why we do not use commercial voltage at 125 or 250 volts and thus avoid the extra expense of special machines, lamps and supplies, for which we are paying from ten to twenty per cent. in addition. The answer advanced is that, while our insulation can easily stand the higher voltage, we are insuring good insulation at the lesser voltage and avoiding the exorbitant losses in search-light rheostats; the commercial practice of placing two search-lights in series has some mechanical difficulties in ship installation.

The application of electricity to naval purposes is now so generally understood that it requires no mention here; the results of those uses as obtained from ship discussion, quarterly returns, official complaint and the large bills for repairs and supplies are the factors with which we are concerned, and which have occupied the attention and close study of those directly in charge of the branch, in order that the faults and remedies could be certainly ascertained and specifications made more stringent to avoid recurrence.

Notwithstanding all the discussion, complaint and repair, it has only been within the past two years that any *range* of information could be obtained upon which to base new specifications which would ensure what we want and are entitled to have.

This has been chiefly due to the fact that the information at hand has been repetitions of facts already canvassed, particularly as regarded increased or increasing coal consumption in the A and B types of the General Electric engines, long since known and admitted as poor types, inefficient and wasteful, if indeed they can, after reasonable service, be pushed to their rated outputs; again, a large mass of suggestion for improvement has been predicated upon experience and device as associated with

the single plant at hand without recourse to changes that have been made or are making elsewhere.

The visits of officers, for acquirement of new information, to the electrical store-rooms and workshops of a well-equipped Navy Yard, where inspection, test, assembling and manufacture of electrical material, appliances and supplies are continually in progress, are rarer than the eclipses of the sun or moon. A navigator or his assistant occasionally appears to look up delayed articles of an approved requisition; a dynamo man strolls in now and then for permission to "look about and pick up a few points," but his thirst for knowledge is quite apt to terminate abruptly at a stray tool whose isolation and position he has probably located previously and which may "come in handy some time." The ship which is building at the dock, with all the newest wrinkles and points, is passed by and forgotten.

So it has resulted that, until a year ago, when opportunity was afforded to repair and overhaul the installations of twelve ships representing almost all the types and classes in the service, information on the general subject has been too meagre to form a good basis for specifications for future work and material, especially regarding the ever vexed and much abused subject of interior communications.

New specifications have been issued this year, which to this date, September 1, 1897, have stood the test of criticism and revision on all cases presented, and are made an appendix to this article.

The general aim has been:

To restrict contract ships to the limits of good workmanship in original installation;

To reduce experimental work and devices to a minimum, *i. e.*, by establishing a system of standards both as a guide to requisition and to ensure uniformity of details and strict interchangeability in our ships.

It is understood that any system of standards is to meet severe opposition from many quarters, but much time and study have been devoted to these electrical standards on the lines of continuity of service, sound electrical principles and simplicity, and needed changes can be made as progress demands. We at least secure for the present that our new battleships shall be installed in the best manner to date. Even then we are trammeled in

obtaining the best, as far as some supplies are concerned, by the two stumbling-blocks, "barring competition" and "proprietary article," which by law prevent us from obtaining in open market what we know to be the desideratum. A familiar example of barring competition is that of lubricating oil, which can be mixed and juggled to pass any devised or devisable set of specifications ever issued.

Good special oils can be obtained by purchase from especial makers and the grade be satisfactorily maintained. Bids must be issued under the law; monopolies crush out the smaller dealers.

Any oil costing less than thirty-five to forty cents per gallon is, for dynamo use, an object of distrust.

"Proprietary article" is a favorite recourse with contractors when "barring competition" will not fit or fails of success.

Our engine indicators have had an especial experience under this head. Whatever may be the niceties and novelties of device in these instruments, faith in their operation must be pinned entirely to the integrity of the spring. The Ashcroft-Tabor indicator, so long in successful use in the service and elsewhere, is fitted with a "duplex" spring—two spirals coiled in opposite directions with containing caps—which is patented, but whose longevity, and therefore integrity of action, is far superior to any device in the market; all other like instruments depend on a single spring, whose operation becomes in a short time dubious and unreliable. Spare springs are provided if one only could tell just when the old should be replaced; with the Tabor instrument there can be little doubt on the subject.

Two instances of the results of the above examples:

Ten thousand gallons of mineral oil (nearly 200 barrels) were delivered into store at the New York Navy Yard in the fall of 1896; were inspected later on, having time to settle meanwhile, and passed into store; the bid was seventeen cents per gallon. The first issued was used on the journals of the 8-inch shaft of the 250 H. P. engine driving the electric plant of the Navy Yard, and at a critical time when the plant was supplying light for getting up steam on a ship about to be undocked. So excessive was the amount of grit and dirt in the oil that the plant could be kept going only by use of a liberal stream of water from a hydrant until better oil could be obtained; filtering produced but

little effect; the oil was also very deficient in "body," a matter that no amount of filtering can reach.

Until recently the Tabor indicator has been our regular supply, but some makers of single spring instruments have supplied a lot by underbidding and successfully over-riding rejection by reason of the patent held on the duplex spring.

These cases are growing fewer in number since the standards have been adopted; contractors are not prone to face the expense of delivery, removal and redelivery where it is expressly stated on the face of the schedule that samples are to be seen on application.

The unsettled questions of to-day, fortunately few in number, are rather those of mechanical details than electrical principles. Good design, efficient insulation, sound connections and thorough water-tightness mark the not uncertain road to security and success in original installation, of which design alone will be progressive and variable. Continuity of service and confidence on board ship rest upon intelligent operation and mechanical aptitude.

Continuity of service and endurance of our plants is now suffering from lack of interest, and apathy on the part of officers. The pioneers of our naval electric installations, and who are perhaps, popularly supposed to be still at the head of affairs, have been called away by the exactions of rank or duty, and but little new blood is being infused.

It is difficult even to obtain inspectors for the various works of contractors, or, at least, difficult to obtain at those points the services of an officer who feels himself in a position to cope with the subject.

The navigator on board ship is charged by regulation with the responsibility of the whole installation; his duties in the other branches of his department, coupled with correspondence when off the bridge, leave him but scant time for the electric plant in its numerous details; his duty ashore has often been in connection with other branches of the service, which gave him but little time for anything more than a very general interest in electricity or its details in ship construction. Placed on board ship, in charge of a large and expensive plant, he must rely on the assistance of the Navy Yard force or be relegated to a dependence on his head dynamo man, which is usually leaning upon a broken reed.

Our installations have been brought to a high state of efficiency through the research and stiff-necked insistance of those who worked out its early details; what we need most now are care and skill in manipulation.

We have the right to point with pride to the achievements of our early pioneers, who came into the field to face the difficulties of a proposition entirely in the air, environed by a fast changing and improving science, without so much as a satisfactory generating set for ship use, with ill-matured appliances and poorer wire; to the fact that it was a naval officer who first suggested direct connection of dynamos to their engines, now so popular commercially, and imperative on board ship; that another officer designed and inspired the first successful fire-proof installation in this country, that of the Broadway Theatre in New York; and it is to be regretted that their sort is seemingly to disappear from the field unless some measure is taken to supply their place.

Short-Stroke Engines and Water Consumption.

The final summation of all energy developed by the generating sets, both useful and wasted, is the consumption of water, of which the practical evidence is the coal account and expenditure.

The wasted energy can be properly divided into two heads:

1. That which is common and necessary to all engines, somewhat increased by wear and tear, but still approximating a fixed maximum.

2. That which is due to losses from the faults of which we treat.

Losses comprised under the second head are those which are remediable and should be eliminated; those comprised under the first head are remediable only in design, and form the basis of competition amongst engine-builders, particularly amongst those builders who are interested in the modern short-stroke types.

Defined as those used for driving machinery which runs at a high speed of rotation, such as dynamos, centrifugal pumps and the like, short-stroke engines have of late been the subject of much rivalry amongst designers, both as to the merits of single-acting as opposed to double-acting engines and simple versus compound.

The questions involved are not those of high-speed engines alone; the difference exists in the fact that "high-speed engines" is the title of a class as opposed to "low-speed engines," and includes engines used for torpedo boats and locomotives in addition to the short-stroke types; the last-named types, having a stroke of from but five to six inches, are alone those with which we are concerned.

The most concisely stated review of the short-stroke types is contained in a paper read in January, 1897, by Mr. J. S. Raworth, a well known English builder and designer. This paper presents the very remarkable statement that, from observations of experiments with over 100,000 I. H. P., it is established that modern short-stroke engines are at least quite equal to long-stroke engines in mechanical efficiency; as it cannot be accounted for on a simple theory of constant thrust, ready explanation is to be found in the better lubrication of the working parts, and in the better distribution of stress by reason of the increased inertia due to the high rate of reciprocation of the pistons.

The necessary waste steam consumption in an engine is usually distributed amongst four well established sources of loss:

1. Clearance.
2. Port friction.
3. Condensation.
4. Leakage.

Clearance must be provided for easing the racking strain of fast piston reversals, and must necessarily increase in percentage as the number of reversals is increased.

The *volume* of clearance in any given pattern of engine varies with the area of the piston and is nearly independent of the length of stroke; but when expressed as a *percentage of the volume of the cylinder* it will obviously increase as the stroke diminishes—the usual 3 per cent. on a five-foot stroke would become 36 per cent. if the stroke were reduced to 5 inches.

This clearance loss is severe in all short-stroke engines and is practically constant for the type.

Port friction may be defined as a sort of added clearance, the volume necessary for the ports, combined with a choking of the steam in its passage to the cylinder. This loss is nearly a minimum in our dynamo engines, as the ports are fairly large and straight.

Condensation is found in all reciprocating engines, and is principally due to the fact that the wall of the cylinder is alternately exposed to high and low temperatures. It is stated that the temperature difference approximates 180° F., about that between boiling water and ice.

In a compound engine the temperature difference is approximately halved in each cylinder, with necessarily great reduction in condensation.

It is obvious that the rate of cooling will vary with the time of exposure, that is, it will be less with increased speed, and in general it is established that there will be a saving of nearly one-half by doubling the speed. This is only an approximation, however, as part of the condensation is due to the radiation of the atmosphere, and another part to the direct conduction of heat from the cylinders to the bedplate and working parts of the engine. The Case engine used with some smaller types of machines is a familiar example of this conduction. In almost every test the water and oil will boil out from the well in the base, at first slowly, and then violently, as the temperature rises from the heated crank. An air tube has lately been suggested as a remedy for the difficulty, but thus far has had no practical trial.

This Case engine will generally slow down of itself as the temperature rises, then, as the temperature falls, is will work back slowly to the original speed, causing a very objectionable fluctu ating voltage in the circuits.

Steam jacketing is naturally suggested as a remedy for condensation, but in short-stroke engines, even when compound, the gain in the cylinder is so evenly balanced by the large loss in the jacket as to render the expedient expensive and unnecessary.

The fourth source of loss, leakage, is one with which we are especially concerned, as it is an inherent vice of piston valves—our usual type—and is not only much increased by wear, causing back pressure and increased loss from that source, but it appears in the cylinders as well, as the pistons wear, destroying pressure, which means more coal.

Valve leakage will be readily understood when it is stated that from this loss alone it has been found that engines, apparently in good order, even when standing still, took as high as 30 to 40 per cent. more than their normal requirement of steam;

and, though the automatic governor handled them well as new engines and when running without load, they ran practically independent of the governor under the new conditions until loaded to about 20 per cent.

From 15 to 20 per cent. of the steam delivered at the throttle is the plain statement of the summation of these four losses in a new dynamo engine that has been subjected only to those preliminary trials necessary to put it in proper order for turning over to a commanding officer, and the statement is believed to be conservative. It does not include water in the cylinder, which is practically indeterminate.

What occurs in service is best illustrated by the case of the Marblehead; in that ship the coal expenditure for auxiliaries increased over one hundred per cent. above the amount necessary at first commission. This is unquestionably a serious matter, especially when, on protracted voyages, economy in the visible coal supply must be rigorously observed and enforced.

The dynamo engines do not use all the coal charged up to auxiliaries, but from the nature of their use they are responsible for a large proportion of the expenditure, certainly for a lion's share of the increase.

Several commanding officers have recently inaugurated experiments for the purpose of ascertaining this increase. Usually such results are in error for the simple reason that there is rarely an opportunity on board ship when the dynamos can be run to the exclusion of all other auxiliaries. The following means of obtaining a fair approximation are suggested:

The best time for the test is probably between six and eight o'clock in the evening, as steam for the galley, flushing pumps and blowers can be best spared at this time.

Shut down everything using steam except the dynamo under test.

Break the joint of a pipe leading to the feed tank, or better, the auxiliary condenser if practicable.

Provide a steep-tub for catching and measuring the water, and carefully measure into it enough water to fill it to within two inches of the top; this will be about 30 gallons, 250 pounds, for the ordinary tub that is used about the galley. Mark the level on the inner side of the tub. It is merely necessary to count the number of times the tub is filled, emptying each time directly

into the bilge and catching the water for the moment with a bucket.

The dynamo should be run with at least 75 per cent. of full load, as dynamos are never efficient or economical at loads below that percentage.

The voltage and load should be kept as steady as possible, and the voltmeter and ammeter should be read every fifteen minutes in order to obtain a good mean.

An hour and a half is sufficient time for the test, but it is better to run for two hours if it can be done.

A set of cards should be taken each hour.

The ratio of the output, as determined by the product of the mean current and voltage, to the horse-power obtained from the cards is the over-all efficiency for that load; the water consumption per K. W.-hour or per I. H. P.-hour is readily obtained from the quantity of water used.

This may appear, at first blush, a rather rough method, but in reality the results will be found to be quite satisfactory.

Data of this kind are very much wanted, especially in engines where the coal consumption has increased.

On acceptance tests the water is measured directly at the surface condenser by draining into a barrel which rests on a platform scale and can be emptied by a stop-cock. The water is weighed every fifteen minutes, the instruments being recorded every half-hour throughout the four-hour-heat run.

What the water consumption of our engines should be has never been determined, that is, no specification is made which covers the important point; at the same time if a specification were made the engine-builder would be quite sure to step in and say that it was too stiff and unreasonable.

For 24-K. W. types and upward it would seem that a new engine should not require more than 35 pounds of water per K. W.-hour if compound, or 42 pounds if simple.*

A 50-K. W. set has recently been built on the designs for the single sets of the Kearsarge and Kentucky which consumed, on acceptance test, but 30 pounds per K. W.-hour, confirming the liberality of the above figures.

* A kilowatt is a thousand watts; a horse-power is 746 watts, practically 750 watts. A kilowatt is therefore equal to 1⅓ horse-power, and a horse-power to three-fourths of a kilowatt.

There seem to be no data as to the water consumption of the numerous engines of the General Electric Company's manufacture which we have, but in the A, B, and those of the C types which have no packing rings, the consumption must originally have been between 50 and 60 pounds per I. H. P.-hour. The two A type machines in the Maine are now using over a hundred pounds per I. H. P.-hour, which, of course, is very excessive.

The remedy for large water consumption is more closely fitting valves and, in engines not so fitted, packing rings on the piston; a number of engines have been repaired in this way aboard our ships and the coal expenditure materially decreased.

Throttling down, reducing pressure when running under light loads, particularly at night, is a common practice of dynamo men which cannot be too strongly condemned. They do it usually under the impression that they are saving steam and also because the governor is inclined to be a little noisy at small loads if the throttle is wide open. The valve fit is what is known as an expansion fit, the best results being secured at the steam temperature of the standard pressure of the design, viz., 100 pounds for compound engines and 80 for simple engines; throttling down, reducing pressure and therefore temperature, must therefore promote leakage past the valve.

At any load the governor will regulate the expenditure of steam more efficiently than can any dynamo man at the throttle, and it should be the invariable practice to run at the prescribed number of revolutions as shown on the name-plate * with the throttle wide open and let the governor take care of the steam, as it was designed to do.

The theoretical governor for best economy is one that cuts off from full to half load and throttles from half load to no load; thus far all governors constructed on the principle have been mechanical failures.

Reduced steam pressure is another fruitful source of waste

* Name plates usually show the name of the manufacturer and the type or form together with the rated speed and capacity of the machine, thus:

M. P.—4—50—400,

which signifies—Multipolar, four poles, 50 K. W., four hundred revolutions per minute. A plate is attached to the bedplate of both dynamo and engine and should show the frame number of the dynamo and the number of the engine for convenience in ordering spare parts. The armature number is generally stamped on the end of the sleeve or shaft.

steam on board ship. Engines are run at pressures as low as 35 pounds, for the reason that no higher pressure is to be had; neither the engine nor governor was ever designed to work economically at any such pressure, nor will they. If no higher pressure than 50 pounds for a simple engine, or 65 pounds for a compound can be had, and coal economy is desirable, it is better to shut down the plant and burn oil; it may not prove an economy in so far as the ledger account is concerned, but it is the certain way to save coal. The remarks made on throttling down apply here with equal force.

A corollary to reduced pressure and throttling down is throttle governing. When the governor has quit, so to speak, as our very troublesome one on the General Electric types A and B generally does within a short time, dismantling the governor or blocking it, thus reducing the system to a mere fly-wheel arrangement, is the only resource, and throttle governing is made compulsory. It is necessarily, though unavoidably, wasteful of steam, and is attended with some danger to the engine if care is not taken to raise the carrying capacity of the dynamo main fuse at the switchboard. Take, for example, the case of a 32-K. W. machine running along with a load of 350 amperes, the throttle practically wide open, governor dismantled or blocked, and governing by the throttle. Presume now a sudden overload to push back to the switchboard a heavy momentary current which we will assume to be 600 amperes; the main fuse would immediately blow, as its carrying capacity is only 400 amperes, and the armature would be safe. Not so the engine; all load has been suddenly removed from it when under full head of steam and no automatic means of shutting off steam is at hand; it is apparent that unless the dynamo man gets quickly to the throttle the engine can do itself any damage up to racking to pieces.

If that dynamo main fuse had had a capacity of, say 800 amperes instead of 400, and the same large current had rushed through, the overload would have slowed the engine and the dynamo armature would have had to stand the brunt. This state of affairs is rather undesirable, but as our dynamos can be relied on to carry, for a brief time, an excess of at least 50 per cent. above their rated capacity, overloading the dynamo is far the lesser evil as compared with wrecking the engine.

The matter is not fanciful or exaggerated; it has occurred in the service, resulting in that instance in a broken connecting rod, attributed, however, to water in the cylinder. Water in the cylinder is a ready explanation of most of these accidents to small engines, for the reason that the cylinder heads are very strong in comparison with those of larger types, and will not usually blow out; in the case of the Katahdin the four stanchions which support the cylinders carried away, tumbling the engine on the deck, but the cylinder heads held.

In the case of the connecting road the presence of water was not well established, while the evidence showed that the engine suddenly raced away and broke the rod before the attendant could get to the throttle; the main fuse of the dynamo was found to have blown.

In one ship in the service, running with blocked governor and throttle-governed, the head dynamo man has *reduced* the carrying capacity of his main fuse; this means that he has weakened the safeguard to his engine and brought the verge of disaster a little closer home.

The Use of Oil in Cylinders.

The majority of the difficulties with our generating sets, of the troubles at least which occasion most frequent remark, complaint and repair, reside in the engines; the dynamos usually give little annoyance.

These difficulties are met with mostly in the A and B types of the General Electric engines, which types constitute over 50 per cent. of all that have been installed, and are admittedly inefficient and uneconomical after short service use; that they are so is the silent protest against the prohibition of the use of oil in cylinders.

Immediately after this prohibition was promulgated, other makers of short-stroke engines, Armington and Sims, Ball and Wood, and Westinghouse, for example, simply refused to build engines under such a restriction, withdrew from our market and declined to make any bids on the specifications.

The General Electric Company then stepped in and undertook to supply the engines as specified, and after a long series of efforts and designs, of which their A, B, and C types are familiar service examples, they finally put packing rings on an engine supplied to the Massachusetts in January, 1897, and used a little

oil. The company has now practically retreated from the field, as the experimental set representing the design intended for the Kearsarge and Kentucky has a lubricator on the steam pipe.

The consensus of opinion amongst builders of the short-stroke types seems to be that cylinder oil is a necessity to endurance and economy, and it is the fact that in but one ship in our service, and this after supplying packing rings to the piston, has the water surface proved satisfactory; in that ship the plant was under the supervision of an officer high up in the electrical councils of the Navy, which is "another story." The saving in coal from the use of rings in this case was over 30 per cent.

It cannot be gainsaid that oil in the exhaust steam exercises a very pernicious effect upon condensers and main boilers, and that the ground against its use is well taken. On the other hand, it is quite certain that the effort to run engines without any lubricant in the steam has been very costly for us in coal, due to bad governing and to the large increase in water consumption from abnormal wear of cylinders, pistons, and valves; this wear, as before stated, has for its remedy packing rings on the piston and closer fit, both demanding, practically, oil in the steam, though the statement is disputed.

Those who protest against the use of oil, comprising about all who are responsible for boilers, usually point out that main engines, such as those of the New York and Cushing, are continually run without any cylinder lubricant; but it is also the fact that the cylinders of main engines, when at rest, are coated with a heavy oil or vaseline for the purpose of preventing the pistons from "freezing" (rusting) to the cylinder walls, and it may be an open question whether an oil-coating, once formed, will permit the formation of a water surface thereafter. In the case of the Cushing it is very difficult to get into the cylinders at all, and for that reason her pistons must usually work on the lubrication of the water surface. In neither case have we an example of a short-stroke engine, which fact is entitled to its due weight.

The solution of the matter for both sides seems to rest in the use of an appliance on the exhaust which will extract the oil from the steam on its way to the condenser. Several designs of this nature, variously styled steam-washer, grease extractor and oil eliminator, are to be had in the market, showing efficiencies as high as 75 to 80 per cent.; assuming the proper amount

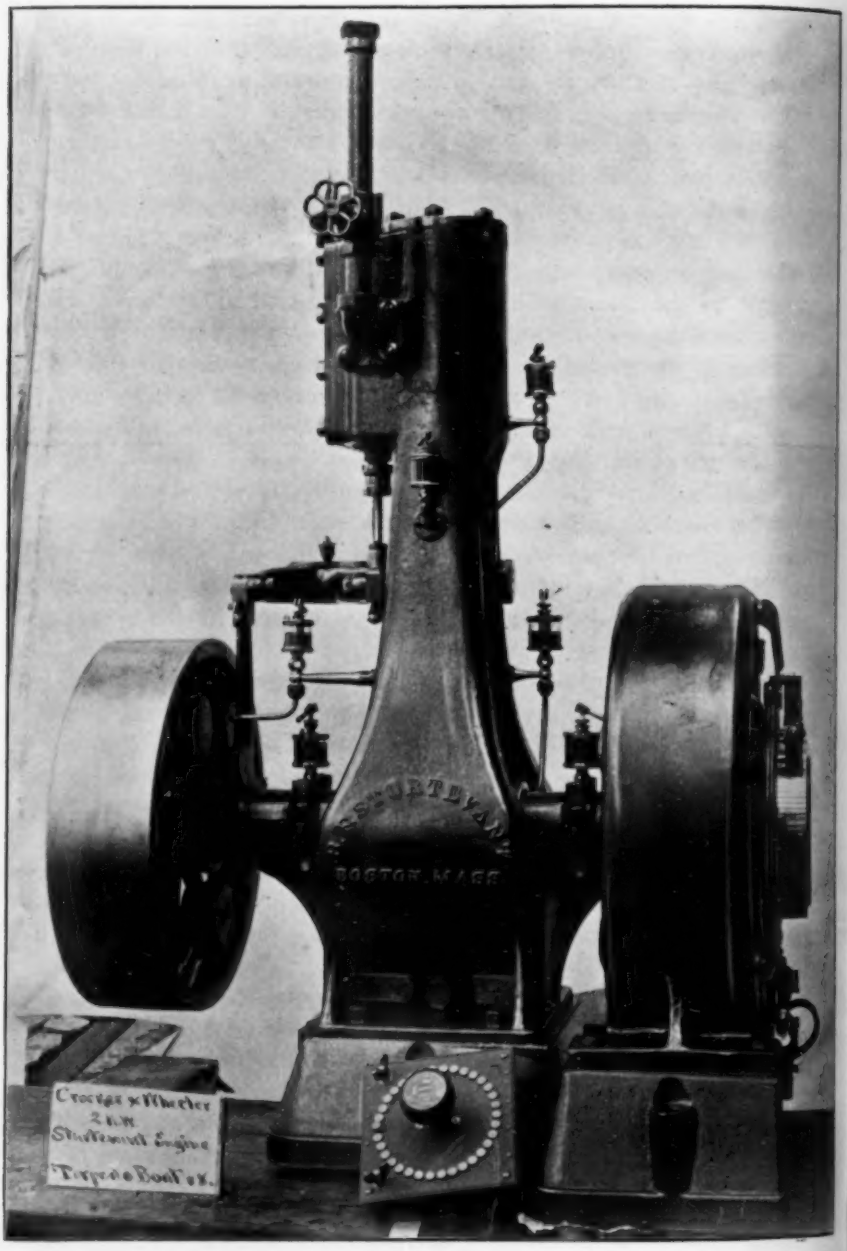


FIG. 1.

2-K.W. Set for Torpedo-Boat Rowan.

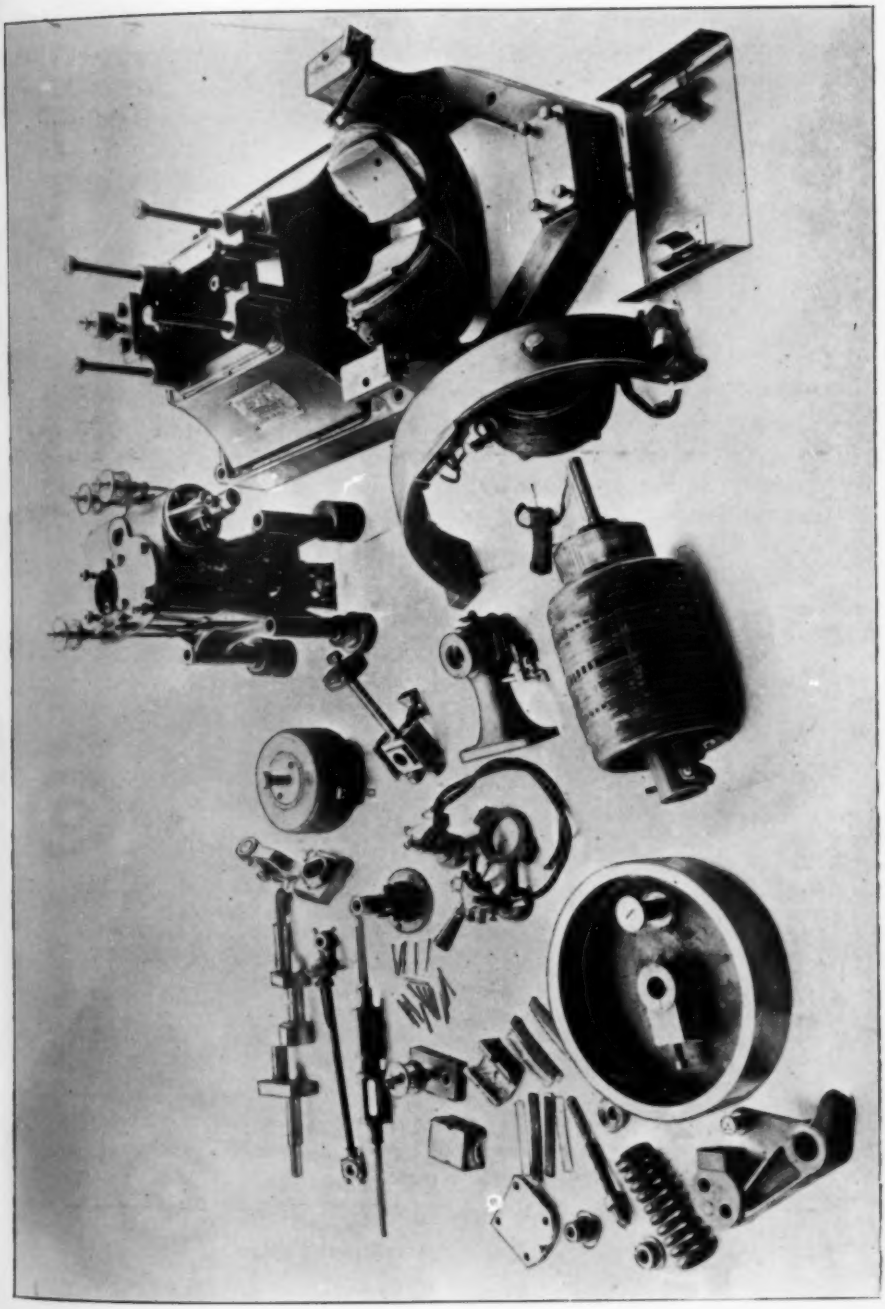


FIG. 2.

2-K.W. Boat Sets.

of oil to be used at ten ounces per diem, this appliance would undoubtedly protect the boilers and condensers sufficiently to remove all objection.

Unfortunately all types of the many designs in successful use commercially are for atmospheric exhaust only, and thus far not a single one has been found that can be recommended for a condensing engine.

Experiments in that direction are making.

Engines.

The discussion of engine faults resolves itself mainly into treating of those of the General Electric types, as well for the reason that they constitute so large a majority of all we have in use, as that it is in those types that the faults have been chiefly observed, whether due to the particular designs themselves or to inherent characteristics of engines in general; and it is but just to remark parenthetically, that on original test no engines could operate more satisfactorily or accord more closely with the rigid letter of the specifications, except, perhaps, in the matter of the noise and want of balance of those having 90° cranks.

We can dismiss from the consideration the types of other makers with a brief remark for each.

A few generating sets with especial types of generators have been introduced from time to time for experiment; they have generally been small sets of 2 and 4 K. W. capacity, in which neither efficiency nor economy was sought or expected. Of these the Sturdevant engine (Crocker-Wheeler generator) showed the remarkable regulation of one per cent. from full to no load, five revolutions at a rated speed of five hundred. The set is shown in Fig. 1; it is installed in Torpedo boat No. 8 (Rowan). The General Electric Company have supplied a very pretty little engine for the boat sets, having a rotary valve. The set is shown in Fig. 2. Its operation is absolutely noiseless. The engines of both these sets are quite heavy for the capacity, and develop an over-all efficiency of between 50 and 60 per cent., as against 83 to 86 per cent. in larger machines.

The Ericsson set, with Case engines, is shown in Fig. 3.

The remaining large engines are mainly those of Bellis, Arm-

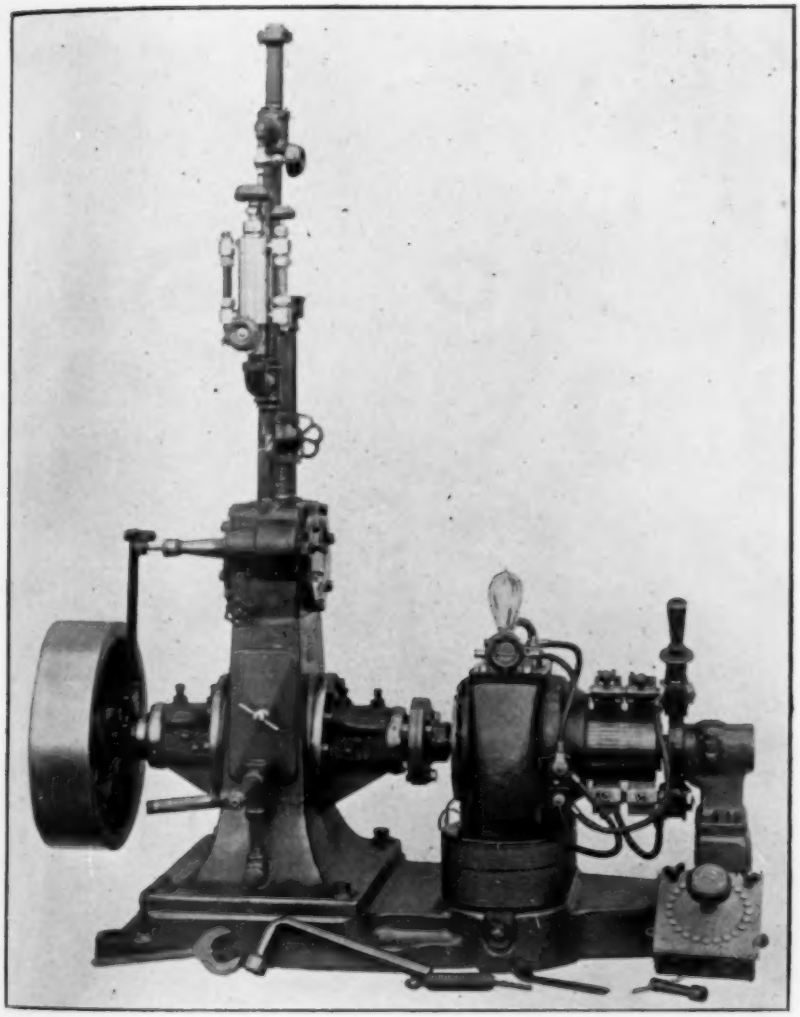


FIG. 3.

2-K.W. Set for Ericsson, with Case Engine.

ington & Sims, and the Union Iron Works; all use a lubricant in the cylinder.

The Bellis-Siemens sets (Fig. 4) were bought in England. The engine is of good, strong construction and works well. It has the disadvantage that the governor action is that of throttling, which occasions poorer regulation and economy than we have a right to expect now-a-days. It is possible to adjust the governor for any steady load, but the adjustment will not answer for any other load. If left to govern according to the design, the speed becomes variable at fluctuating loads, resulting in irregular voltage.

The series field of Siemens generators is wound outside of one shunt coil only, causing a difference of intensity at the periphery of the armature, making it a little one-sided, so to speak. In addition the dynamo has the large stray field common to all bipolar constructions. The sets, however, give little trouble and are for that reason quite popular on the ships in which they have been installed.

The Armington & Sims and Union Iron Works types have proven very satisfactory after extended use; the latter are generally cross-compound, even in sets of four kilowatts.

The general appearance of the A and B types of the General Electric Company's manufacture is shown in Fig. 5. In reality the two types are practically one, as the only important difference lies in the construction of the engine bearing nearest the dynamo. In the A type this bearing consists of two bearings, one of which is boxed off from the engine frame; in the B type the box bearing is omitted, the other being made a little longer; this arrangement adds materially to convenience in handling the shaft.

The engines are simple and designed to work at 80 pounds of steam.

The valve chests are located between the cylinders, and directly under them on the shaft is the governor carrying the eccentrics for the valve stems. The crank shaft and armature shaft are in one without coupling, the dynamo end being provided with ring oilers of the type shown in Fig. 6. The cranks are at an angle of 90°, causing the want of balance and noise predicted for them in a previous article of the Institute.

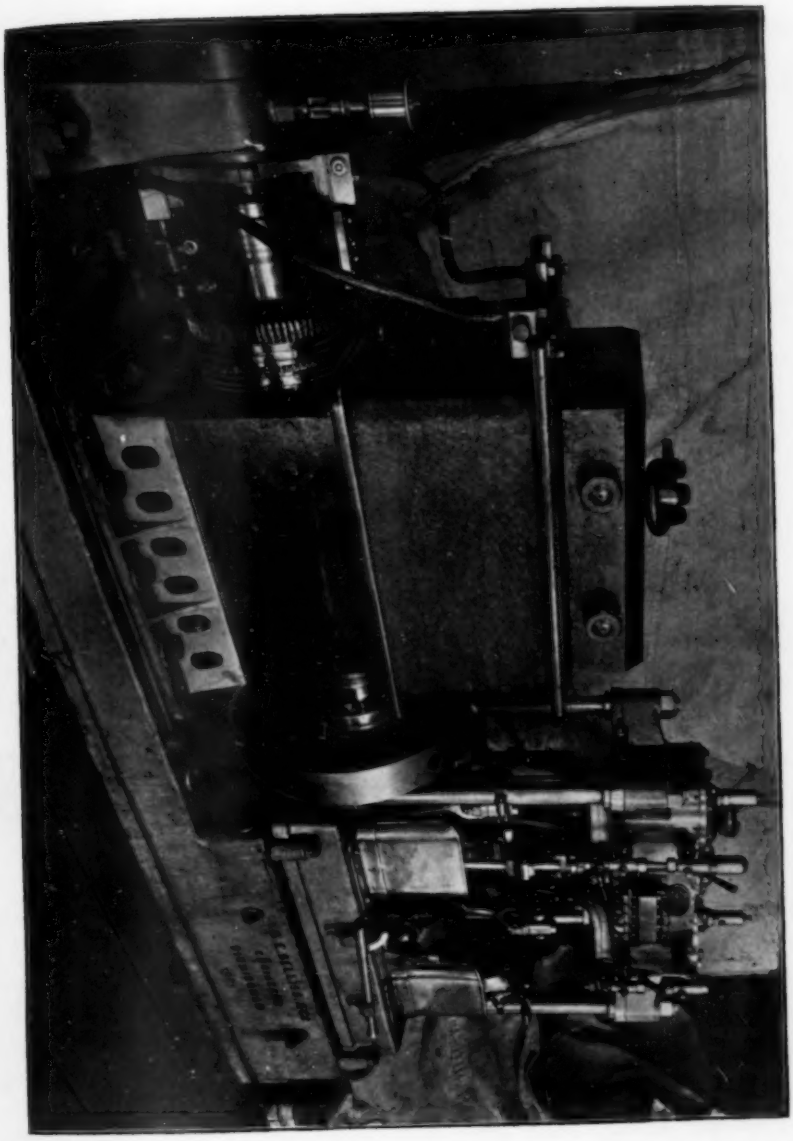


FIG. 4.
Siemens-Bellis 32-K.W. Set.

Cylinders.

The chief fault has been abnormal erosion and wear, of which the Marblehead, and to a lesser degree the Columbia, have furnished the best examples.

When the bonnets were removed it was expected that the wear would be practically equal all around, but there was found, in addition to a deep scoring, an oval wear, in the plane perpendicular to that of the shaft; the edges of the piston were worn and the rim rounded off. The leakage of steam from the steam side to the exhaust side of the piston must have been very great.

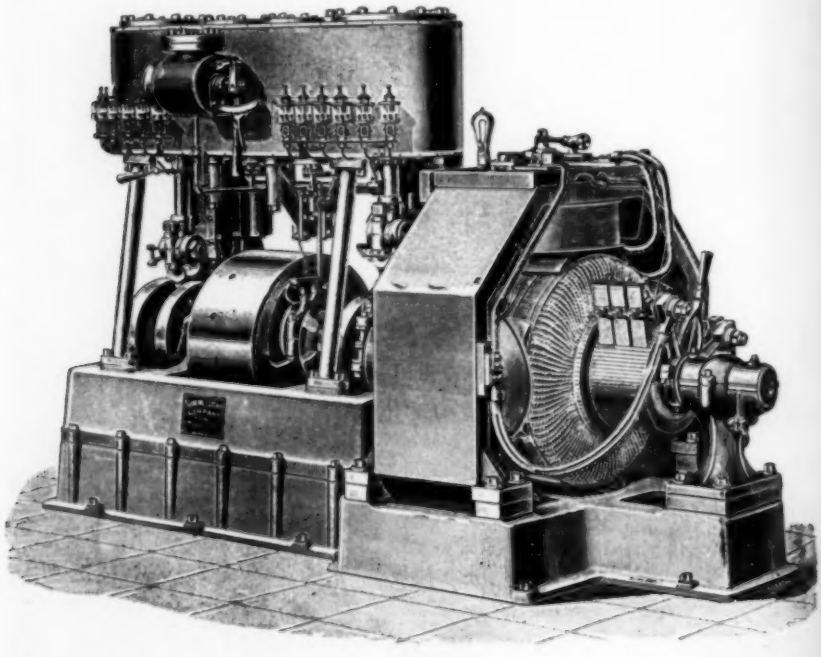


FIG. 5.

Electric Set; Engine, Type A

This oval wear is unquestionably caused by the cocking of the piston. The cross-head is supposed to prevent this, and it is evident that there must have been a lateral play of the cross-head in the guides, which had not been taken up. In a C type machine, lately supplied, the pistons are centered by a tail rod;

K.W.	Sleeves Types A, B, C.		
	Mark	Length	Bore
32		10¾″	2⅜″
24		10¾″	2⅜″
16		8¼″	2⅛″
8		8″	1⅞″

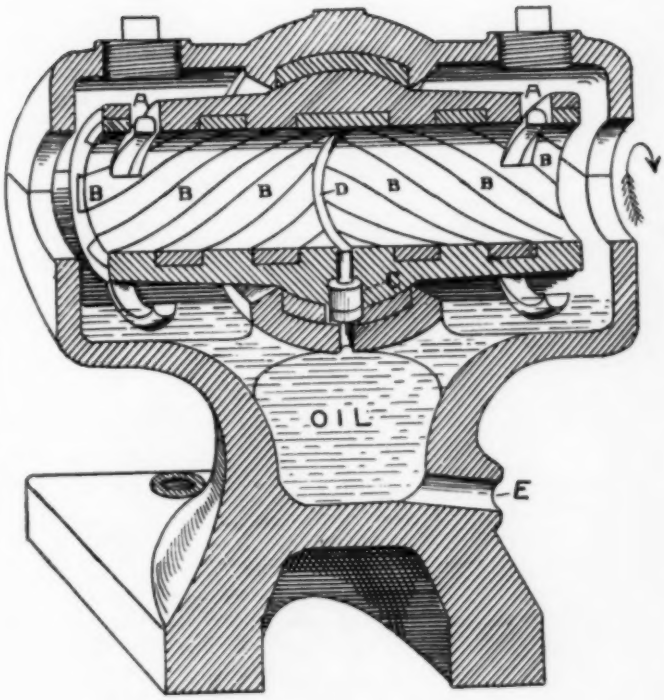


FIG. 6.

Self-Oiling Bearing for Generating Sets.

The bearing itself is a sleeve held in the pillow block by a ball and socket joint, and hence is self-lining. The lower part of the pillow block forms a reservoir for oil. Two slots in the upper part of the sleeve are cut transversely, on near each end, exposing the upper surface of shaft at these places. Two bronze rings (*A A*) dipping below the surface of the oil in the reservoir, rest on the exposed parts of the shaft and are driven by it. The sleeve is cast iron. On the bearing surface of the sleeve, spiral grooves (*BB*) are cast, running right-handed from one and left-handed from the other end. These grooves are filled with babbitt metal, the bearing surface thus consisting of spiral bands, alternately babbitt and cast iron. A groove (*D*) is cut round the middle of the sleeve, where the spirals meet; it communicates with the oil reservoir by holes (*C*) in the ball of the sleeve and the socket bearing of the pillow block. The oil may be drawn off from the reservoir by a pet cock screwed into the hole (*E*) in the pillow block.

When a machine with bearings of this construction is running, the motion of the shaft keeps the rings (*A A*) continually revolving and carrying oil from the reservoir to the ends of the bearing. The oil delivered at the ends of the bearing is swept towards the middle of the sleeve by the action of the revolving shaft on the spirals. At the middle of the sleeve the oil is collected by the groove (*D*) and returns by the hole (*C*) to the bottom of the reservoir where it has time to settle and cool.

Depending only on the motion of the shaft, the oiling action of this bearing is entirely automatic. Starting the machine starts a flow of oil through the bearing which is continually maintained whilst the machine is running and stops the moment the machine is stopped.

An arrow is cast on the upper surface of the sleeve, and the latter must be set so that the upper surface of the shaft runs in the direction the arrow points.

It is recommended that these bearings should be examined once a week, although the oil does not need to be renewed as often as that.

FIG. 7.

16-K.W. Piston, with and without Packing Rings.

but it is doubtful whether in small engines the device is worthy of the trouble or expense.

The steam leakage around the piston is best remedied by packing rings. Fig. 7 shows a 16 K. W. piston so fitted, and also the original design without rings. A worn cylinder requires reboring.

The section of the packing ring shown in the figure is square. Rings of this section are prone to break or to cause a clicking noise from want of sufficient bearing surface in the grooves. The later and better practice is to make the ring width from two to four times the thickness, deepen the groove accordingly, and divide the ring into two or three pieces for convenience in entering.

These wider rings are designed to take against elliptical springs, held to the bottom of the grooves by set-screws.

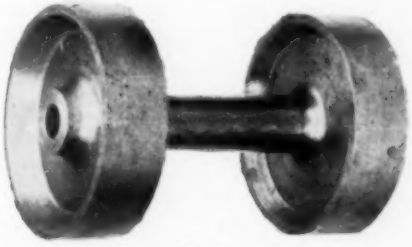


FIG. 8.

Piston Valve.

VALVES.

Fig. 8 shows the usual type of piston valve in use. It has ordinarily been made of bronze, presumably for the purpose of lessening friction and wear. A number of instances of wear in these valves rather demonstrates that the idea is not well borne out. Cast iron is now used, as it not only insures a good expansion fit, from similarity of expansion with the material of the seat, but answers all the practical demands of wear.

Wear of valves and lack in tightness of fit are indicated by the balloting of the valves against the side of the chest, and always means increased leakage. In some large engines packing rings have been fitted; this entails a danger of catching at the ports. best obviated by bridging; in small engines, however, the bridges

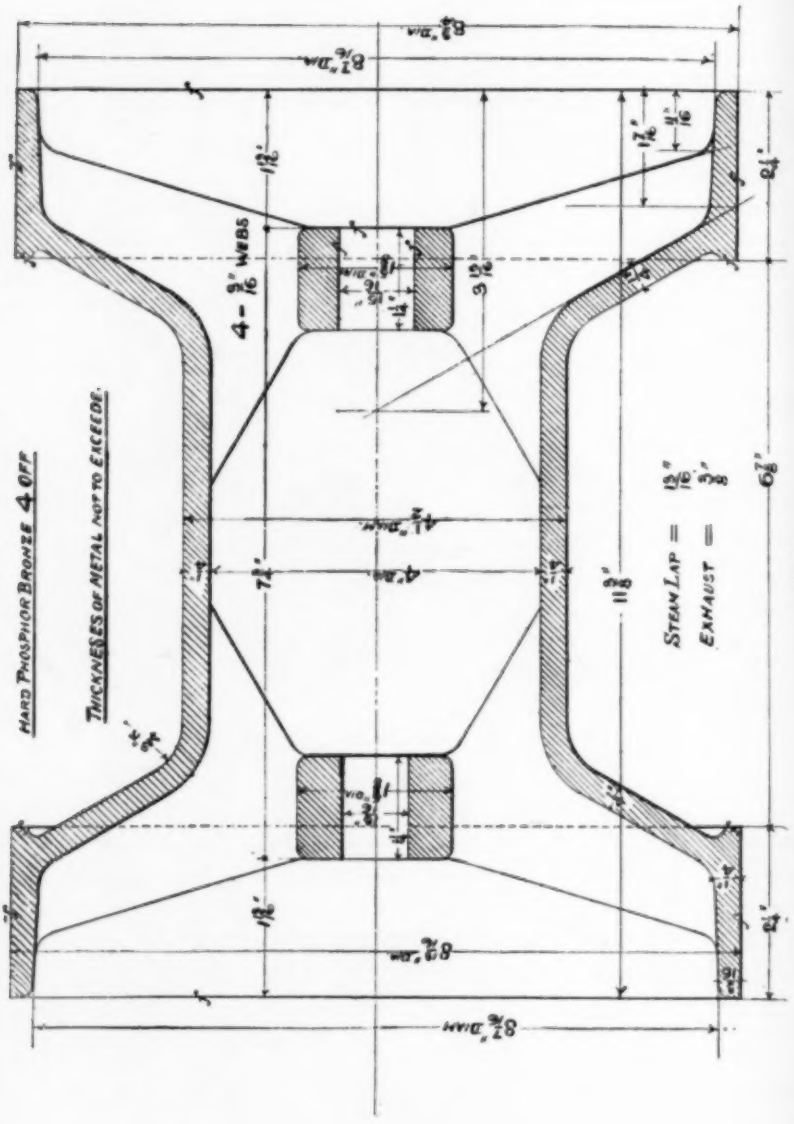


FIG. 9.
Section of 32-K.W. Piston Valve.

would probably need to be diagonal, an annoyance and expense in casting.

Valves often show anomalies even for the same type and size of machine; in some engines the valves are not interchangeable, this is in direct violation of the specifications; in others the lap or lead will be quite different, a troublesome matter in valve setting, which is at best an undertaking of no mean proportions with some of our engines.

The available method is to lengthen or shorten the travel by means of the nuts on the valve stem. In setting valves on the Amphitrite it was found that only a quarter of a turn of the nut, on a thread pitched eleven to the inch, would entirely change the character of the card. What the valve really needed was a little more lead, not attainable for the reason that the eccentric is bolted solidly to the governor casting and cannot be given angular advance. The best that could be done, pending the construction of a new eccentric, was to adjust the work between the cylinders as evenly as possible; when completed the cards showed that one of the cylinders was doing four-fifths of the work, instead of one-half as it should.

The large amount of breakage of valve stems is a question of valve guides and governors, which will be touched upon later on. Fig. 9 shows a section of the valve used with the 32-K. W., smooth body types.

Piston Rods.

These give little trouble; they are very strong comparatively, and escape the effects of water in the cylinder. But a single case has been observed arising at this point, and it was really a matter of the stuffing box; the gland had not been properly entered on the thread, canted instead of catching fair, resulting in binding the rod and stopping the engine.

Crossheads.

It is always at the crosshead that the first trouble with a new engine develops. Fig. 10 shows two views of the pattern used on the large engines of our sets. The connecting rod is fitted to it with the ordinary strap, gib and key. The first fault appears as a rattle, then a decided knock at the pin, with consid-

erable lost motion. It would seem almost unnecessary to point out that the set should be stopped at the earliest possible moment after any rattling or knocking develops and the key set up, yet ships come to the Yard hammering at the crosshead until it would almost seem that the system was to fall to pieces, and in almost every case from sheer carelessness and neglect.

Now, lost motion in any of the working parts, whether it be crosshead, link, governor weight, or bearing, always exists at the expense of speed, slowing the engine as the load is increased, which means low voltage, or racing as the load is decreased, which sends the voltage up.

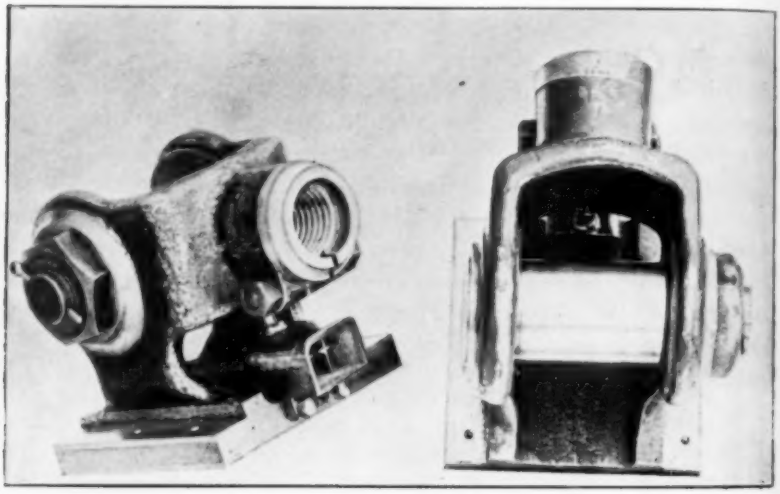


FIG. 10.

Two Views of 32-K.W. Crosshead.

In the latter case we can usually reduce the voltage by the shunt rheostat; but a slowed engine will usually prevent all efforts to get the voltage up to normal, the lights burn dimly with an annoying flicker, and no remedy can be applied until the set can be shut down and the governor spring screwed down.

There is seldom any good excuse for lost motion; liner material in all convenient thicknesses is in store to be required for, and even if these are not available, there is always sheet brass, or tin, or coffee boxes about, which can be hammered to the thickness and small area required.

Crosshead guides wear in time, permitting the lateral play, which is chiefly responsible for the oval erosion of the piston disk before mentioned. This requires some machining, but is quite within the capacity of the ship's force. In most cases the wear of the guides can be traced to insufficient lubrication; bad oil is especially pernicious at this locality, inasmuch as considerable wear may take place before it can be detected by noise.

Cranks.

The crank end of connecting rods is almost invariably a stub-end connection; the brasses are made of the hardest obtainable bronze, and fitted brass-and-brass, that is, no parting piece or liner is placed between the flanges to be removed or reduced as the brasses wear, and it is practically intended that all probable wear will be resisted by the metal alone, except for some little lining up between the top brass and connecting rod, at the same time planing or filing away the flange surface.

If the metal is hard, but little heating, poor lubrication and tight fit apart, be noticed; if soft, the wear is apt to be rapid, necessitating the taking of a good cut from the flange surface, true-boring in a lathe and new oil-ways. Scraping generally meets with little success, for the reason that the bearing surface is frequently reduced, which, in itself, is a direct invitation to further heating.

The calculations of the bearing surface of brasses are based on the thrust and weight to be applied at the journal, an empirical [illegible] energy per square inch determining the total area required. [illegible]y reduction of this area must then cause heating. The proof has been directly demonstrated on board the Puritan. where all measures suggested proved tentative until the brasses were rebored.

A frequent cause of reduction in the bearing surface of crank brasses is want of alignment of the shaft, particularly if the wear on the oil-ways is at all serious.

Fitting these brasses, either new or repaired, requires good mechanical skill; it can be materially assisted by simply roughing the bearing surface of the brass with a half-round file, after the oil-ways are cut. The advantages are:

1. The roughed surface provides a slight clearance, which is not usually allowed, enabling the pin to establish a good working surface.

2. There is a polishing action on the journal which reduces friction.

3. The lubricant spreads more freely to all parts of the journal, particularly to the "dry line"—the line on which the pin is for the moment pressing. The expedient has met with good success in a number of cases, and is well worth trying.

Babbitt plugs and linings as used on ship's main engines prove inexpedient for cranks in the dynamo room. Babbitt boxes will replace brasses in most future engines, and are now fitted to the 32-K. W. sizes; they cannot be fitted to the present engines of smaller sizes from lack of sufficient clearance on the crank discs.

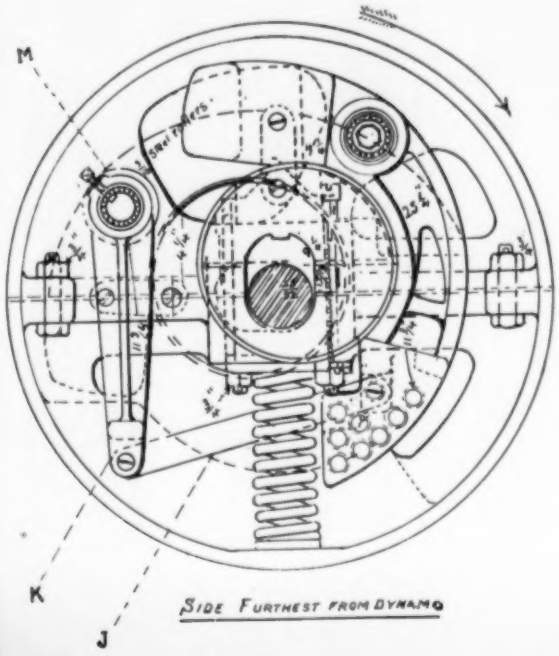
The rule that cranks should be placed at an angle of 180 degrees is imperative; to this any one will assent who, when in quarters aft, has listened to the pulsations of an A type engine located in a forward compartment. Ninety-degree cranks are quite certain to entail bad balance, racking strains on working parts, frequent lining up, vibration, lost motion and irremediable noise.

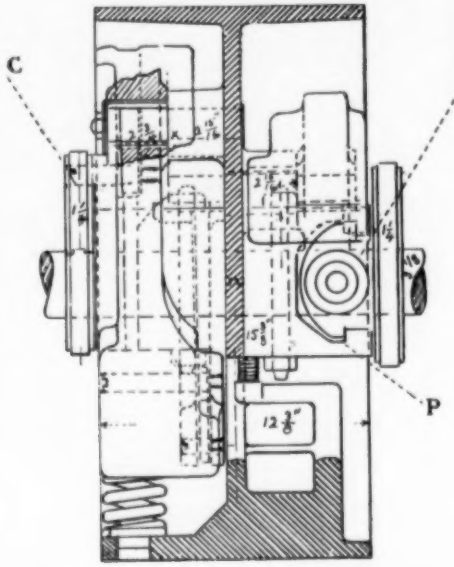
There is no manner of use in temporizing with a hot crank; dynamo men will make an effort, but the use of oil and water will only lead to the same result, which is shutting down and running another set while the crank cools and is examined for the cause of heating.

Shafts.

Springing and bending are the cases we meet with; flaw in material and breakage are rare.

A sprung crank-shaft is direct evidence of want of alignment as well as of an improperly drained cylinder on starting up. The ordinary case, however, is the springing of the line shafting carrying the armature, which has no support between the engine bearing and the ring oiler bearing at the end of the shaft. Referring to Fig. 5 and noting that the upper part of the dynamo frame cannot be lifted, it will be clear that a 1200 to 1800 pound armature, with small clearance and handled with tackles, is liable at any time to permanently spring the 2½-inch shaft as it is moved out. It is from a knowledge of this fact that aligning a shaft is so often put off until the last possible moment, when Navy Yard facilities and workmen are not at hand. All of this





Form A and B.

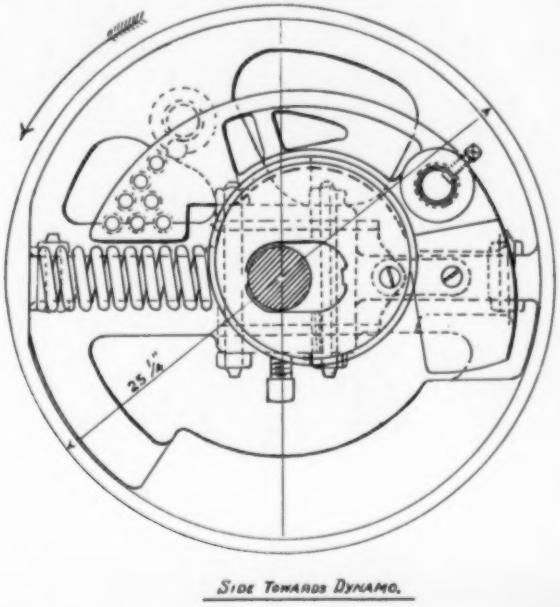


FIG. 11.

32-K.W. Governor Assembly.

handling of armatures can be avoided by cutting down the end bearing boxes, making the shaft end accessible, and should be done at the first convenient opportunity, and, in addition, a short trolley rail and car should be installed for handling the armature to prevent some of the injuries to the insulation of armature coils due to the pressure of blocking.

Later engine shafts have a flanged coupling between the engine bearing and the armature, trolleys are provided, the dynamo field coils are laid in planes of 45 degrees with the vertical (Fig. 17), and the upper half of the frame with its two coils can be lifted off out of the way.

It requires but a small spring in these shafts to send them under the hammer and to the lathe; a new shaft is the more probable result, a matter of fully six weeks after the order has been placed.

Governors.

There is seldom a case of repair in which one or more parts of the governor is not involved. It has been admittedly a troublesome and annoying device. Much of the blame lies at the door of the device; a part of the remainder is attributable to the fact that repairs which would have helped matters somewhat were not made; the rest, to a hazy idea in some quarters regarding the mechanism and its action.

Fig. 11 is an assembly drawing of the 32-K. W. governor, A and B type engines. Fig. 12 is a sketch, not drawn to scale or corresponding with the actual assembly, drawn to show the connection and action of the principal parts.

A fly-wheel with fifteen-inch flange is divided medially by a light diaphragm (solid web in later engines, having lightening holes as shown), and secured to the engine shaft by a sleeve, feather and set-screws. The wheel is divided into two halves to admit of assembly. On each side of the diaphragm are the following parts:

A governor weight, *E*, working on roller bearings; a short link, *D*; a long link, *J*; a weight-shaft lever, *K*; a sheave block, *B*; a shaft, *M*, which pierces the diaphragm and is secured to the weight on the opposite side; and a stiff, coiled spring. The eccentric, *C*, is rigidly bolted to the sheave block.

The action is this:

The weight, *E*, thrown out by centrifugal force, pushes on the

short link, *D*, which transmits the power to the sheave block, *B*. This block is mortised at *H* to allow a motion across the shaft, the amount of motion being controlled by the spring; the eccentricity of the eccentric on the shaft center *A*, and consequently the travel of the valve, is thus changed by every motion of the sheave block. The sheave blocks on opposite sides of the diaphragm work at right angles, since the cranks are at 90°. The roller bearing is shown at *F*, and with the rollers in Fig. 11. The position of the block as shown is for greatest valve travel.

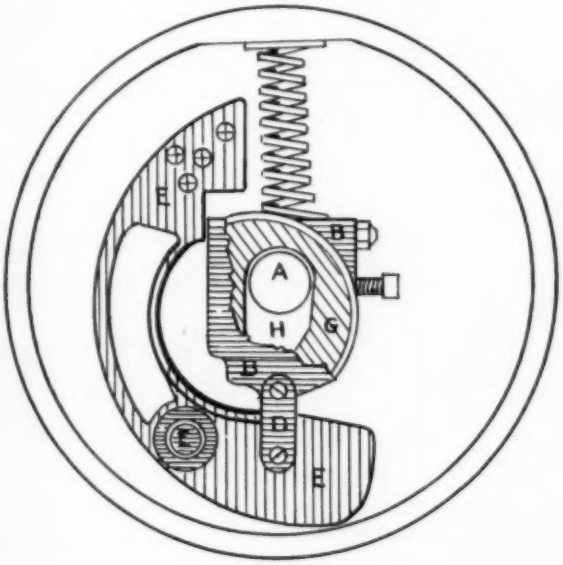


FIG. 12.

By merely tightening or slacking the governor spring, by means of a socket wrench entered through a mortise in the rim of the wheel, we can increase or decrease the number of revolutions for any given opening of the valve ports, or, having set the spring by trial for a desired number of revolutions (usually 400), any increase in the number of revolutions will automatically shorten the travel of the valve and admit less steam, any decrease will lengthen the travel and admit more steam; the governor thus automatically keeps the engine to the prescribed speed.

The long link, *J*, weight-shaft lever, *K*, and weight shaft, *M*, are merely connections between the two weights for the purpose of ensuring uniformity of action.

The first trouble with these governors appears as an elongation of the holes through which the link pins are inserted, and on which pins the links journal. Lost motion then causes a rapid increase in the elongation from the hammering action of the heavy governor weights; elongation of the holes in the long links appears, resulting in stress of the weight-shaft lever, and in some cases in breakage. The weight-shaft levers are made of cast iron, but should be of tough forged steel.

FIG. 13.

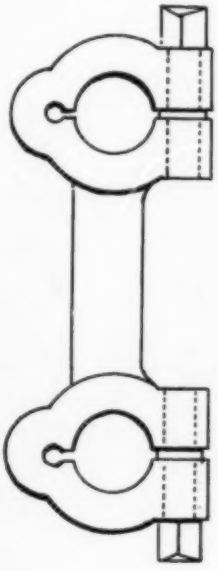


FIG. 14.

Lost motion in a device designed for the direct control of the engine speed is necessarily that to which that engine would be most sensitive, it is more than established in the case of links.

That a device so simple in construction as the link represented by the sketch of Fig. 13, and which can be readily made from boiler-plate or plate steel, is not at once substituted for the worn link has no other explanation than inattention and neglect. The noise of a loose link is unmistakable, even at some distance, and it will not do to attribute all noise in the governor to the hammering of the weights "against the rim of the wheel," as it is often said. The weights cannot hammer against the rim of the

wheel; they can, when running at light loads, hammer against the stops on which the weights take when at rest—particularly noticeable in starting up or shutting down—but at half load or more the feat is practically impossible, and any noise at such loads should immediately cast suspicion on the operation of the links.

Another expedient is to bush the link holes with bronze or steel.

The adjustable link shown in Fig. 14 is furnished with the C type engines; it is simple enough to admit of manufacture with our ordinary shipboard facilities.

The serious fault of the governor is in the roller bearings; it is purely a fault of design. In order to carry out the principle of "across-shaft governing," some means must be provided to

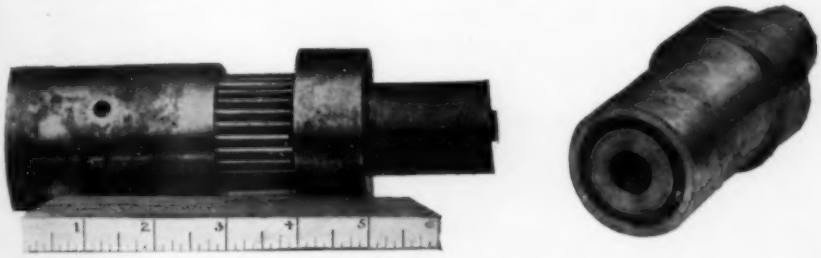


FIG. 15.

Pin, Sleeve and Rollers for Roller Bearing.

relieve the friction due to the pressure of the weight upon its journal; roller bearings were adpoted for the purpose; the pin, rollers and sleeve are shown in Fig. 15. Referring to Fig. 12, the weight, *E*, actuated by centrifugal force and having its fulcrum at the link, *D*, exerts a pressure on the rollers which are on the shaft side of the pin. If the weight revolved about the pin the wear would be equal all around, but with the steady loads in use and the small amount of motion of which the weights are capable, the pressure is exerted at practically the same region at all times. The hard rollers bite into the case-hardened surface of the pin and sleeve, gradually producing deep grooves which, when once the case-hardening is penetrated, rapidly increase; the rollers then act as a sort of key to prevent rotation of the weight or jump from groove to groove, causing very jerky regu-

lation, fluctuating voltage and flickering lights; for motor supply such a condition is very objectionable.

Fig. 16 shows one of the corrugated pins, originally like that of Fig. 15, which was taken from the governor of a new engine after only six months' use; it is not the worst example.

When the worn pin and sleeve cannot be repaired or replaced the only recourse is to reduce the governor to a fly-wheel by blocking and govern with the throttle, involving steam waste and danger to the engine unless the carrying capacity of the main fuse of the dynamo is immediately raised as before explained.

Severing the gordian knot of this difficulty probably resides in abandoning the principle of "across-shaft" governing and adopting another which has proved successful under long use. Of these may be mentioned "line-shaft governing" as used with the Armington and Sims machines, also the tangential method of

FIG. 16.

Pin, originally like that of Fig. 15, showing Corrugations.

Ball and Wood, and the slip eccentric used by Sturdevant; both of the latter devices require that the governor is to be placed on the end of the shaft, where it always should have been, and where it is now placed in our C type engines and those for the Kearsarge.

The remedies at our disposal are to replace the worn pin, sleeve and rollers by new, which necessitates that spare ones should be on board; these should be of hard tool steel; or, to make a new pin, remove the sleeve and rollers and substitute a bronze bushing of equal thickness, a method that has met with great success at New York. The engine will not regulate as closely under the latter method, but by using a thinner oil—the usual lubricant thinned with kerosene—and making changes of load gradually it will be found to work successfully.

Governors are easily influenced by gummed oil or dirt and

should be cleaned frequently; this point is much neglected. A pertinent instance occurred on the ship from which the corrugated pin of Fig. 16 was taken.

Repair had been made by bushing with hard phosphor bronze, the first repair of the kind. At the end of about a week word was received that the governor would not work. Upon taking it apart it was found to be completely choked with gummed oil and dirt—had not been cleaned at all, in fact. When cleaned and oiled it governed as well as before. The head dynamo man naively remarked that his hands were "too large to clean those small holes."

Valve Stems.

The too frequent breakage of valve stems has its ultimate cause in a jerky governor or shaft out of line. The original causes are that the length of the unsupported part of the stem is too great and that the guide casting is too light or has not sufficient strength for the purpose. Vibration and stress soon work the fastenings of the casting loose until, with loose guide and irregular stress from the working parts of the engine, the stem snaps. Two have been known to break in a single night.

Substituting a heavier guide casting and taking up lost motion will bring about a decided improvement.

The C-type Engine.

The C-type engine, of which we now have about fourteen in use, is shown in Fig. 17. Many of the faults cited have been eliminated in its design.

The engine frame is made more compact and is much stronger than the light, stilt-like construction of the former types; a flanged, through-bolted coupling is inserted between the engine and armature on the shaft, thus minimizing the chances of springing when handling the armature; the cranks are set at an angle of 180°, ensuring good balance and lack of noise; the governor is put on the end of the shaft and connected by a rod and rockshaft to the valve links which operate shorter stems in secure guides. In the last engine of the type furnished packing rings are put on the piston. It is a good engine, but has the old fault of roller bearings.

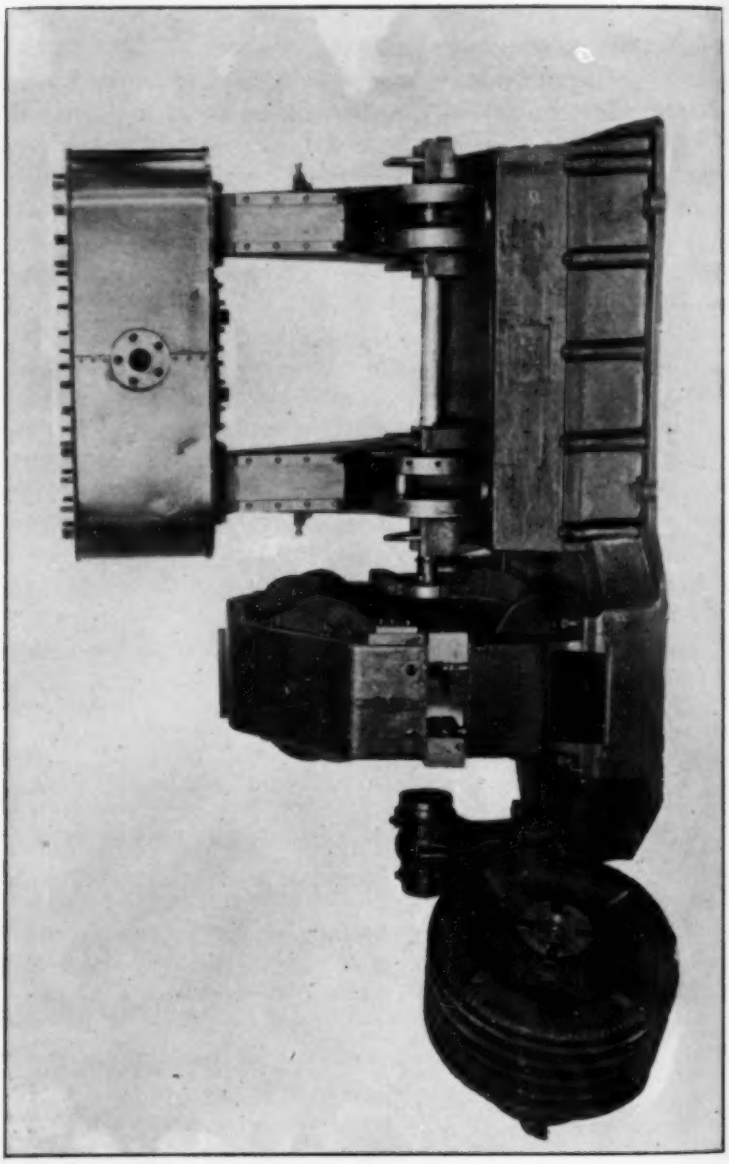


FIG. 17.

The governor, a radical departure in design from the old, but on the same principle of governing, is shown in Fig. 18.

Both weights are on the same side of the web, which does away with the long links, weight-shaft levers, weight shafts and nearly half the width of wheel rim, the necessary weight at the

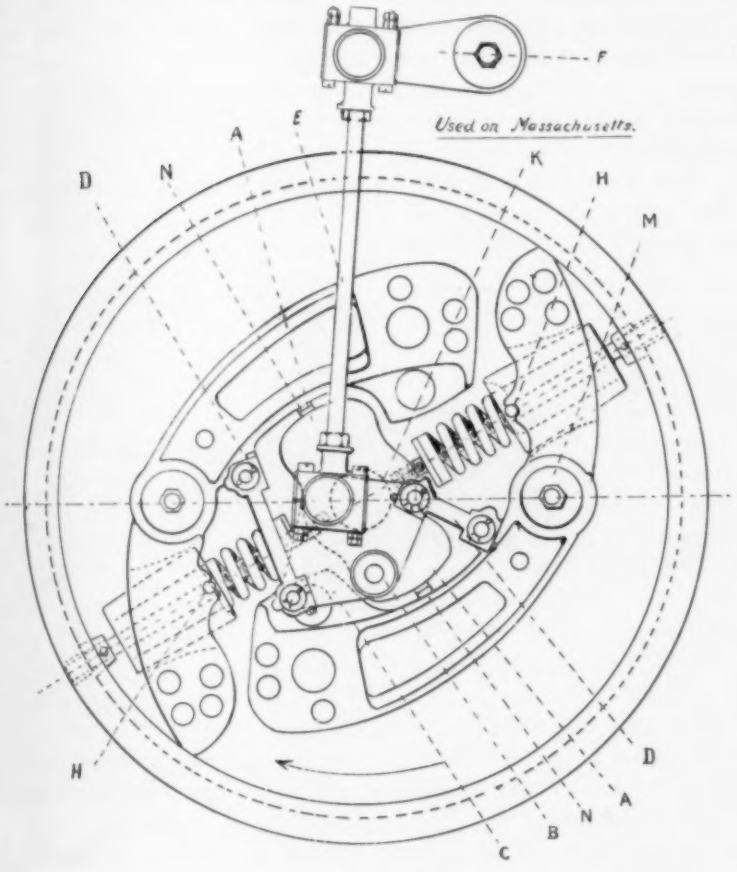


FIG. 18.

Governor Assembly, Engine, Type C.

periphery being obtained by thickening the rim. The construction is as follows:

The mass *A*, shaped somewhat like a guitar body, is cast in one with the web. A pin journal *B*, about which oscillates the

cam *C* (shown separately in Fig. 19), taps into this mass. The cam carries the adjustable links *D*, and the journal of the governor rod *E*, which rod operates the rockshaft *F*. The spring acts directly on the weights through the pin *H*.

The outward motion of the weights actuated by centrifugal force—and resisted by the spring—drags the links *D* and with them the cam *C*, which in turn shifts the center of the governor rod journal toward the center of the shaft *K*. The amount of throw at the rockshaft evidently depends on the eccentricity of the center of the governor rod journal, the full throw being represented by the position of the figure.

The weights take against the buffers *N* when at rest, and as these are cushioned, much of the pounding when starting or stopping is avoided.

FIG. 19.

Cam of C Type Governor.

The roller bearing trouble has come to the front in almost every one of these engines so far examined. In the Indiana the pins of all three sets were renewed last spring and fitted with bronze bushings.

Similar repair on the Massachusetts is awaiting a convenient opportunity, except that in this case it has been practically decided to put in new roller bearings of tool steel. The new set for the Massachusetts, from which Fig. 18 was taken, broke the pin of the roller bearing *M*, due to a flaw in the metal not discernible at the surface. When the pin was taken out a very decided corrugating action was found on its surface; the set had been in use but *three weeks*.

The governor of the Kearsarge and Kentucky sets has but one weight on roller bearings. The pin is made of hard tool steel and increased in diameter from 1⅝ to 3 inches. There has been no experience as yet with the action on tool steel except in the case of the experimental set, representing the battleship (single set) design; this has been run at Schenectady for hours over a range of several months, submitted to all sorts of crucial tests, but now shows no sign of wear of the hard steel surface at the larger diameter.

Perhaps this may be the solution of our vexatious governor troubles in design. We who have the care and handling and annoyance on board ship sincerely trust that it may.

Dynamos.

Our dynamos are all of the constant-potential, "direct-current" order. Since the introduction of the smooth body armature—the modified Gramme rings shown in Fig. 5—but two types have been designed, the A type or form having the pole pieces in the vertical and horizontal plane as represented in the set shown in that figure, and the B type in which the pole pieces are in the diagonal planes; the frame is divided in the horizontal plane, flanged and bolted to admit of ready removal. These constitute the only important differences between the types. Experience with the type of Fig. 5 shows a great exposure of the lowest coil to all drippings of oil and water. This was particularly observed in the port set of the Cincinnati on her return this summer; the coil was so saturated with oil that it dripped from the wire when running it through the wiper.

Apart from the ordinary advantages of multipolar over bipolar constructions, our machines have put out of the consideration the effect of stray field upon the compass. Sir William Thompson has asserted that all dynamos will influence the compass on board ship, and points out that the danger is greatest at night, when heavy loads are carried and when the opportunities for observation are often impracticable. Tests made with both machines at full load on board the Puritan failed to show any disturbance, it is therefore supposed that the foregoing statement, made some years ago, refers to bipolar constructions, as the the multipolar was not in general use at that time.

Extensive trial has also proved that the electric lighting o:

binnacles produced no appreciable effect. The new type V binnacles are fitted with electric lamps, except for those binnacles which are to be located at the hand wheels.

Sparking.

Almost any violation of electrical or magnetic principles in design will produce sparking; it is also true of some errors of mechanical construction. These faults of design are matters for original and acceptance tests; the ship problem presents but few cases.

We have, however, in use two types of machine which, after a short time, spark beyond redemption at any stage of load or position of the brushes on the commutator; these are the Thompson-Houston and Siemens-Halske patterns; there are six all told in the service, and all 4-K. W. machines. Both types have a modification of the "ironclad" construction of armature, which, though very successful in small motors, will not answer for a dynamo. This construction differs materially from the slotted core design, whose teeth and slots are deep and narrow, and whose windings are practically cooper bars. The brushes also should make contact on three bars.

The Siemens-Halske machines in use in one of our ships spark so badly that the commutator is sand-papered two or three times a week to keep it in even fair condition.

Overload is the frequent cause of sparking, and will be shown by the ammeter, except in cases of grounds in the machine itself. It is not usual for the case to occur from extra loads on the lines in circuit, for the reason that the loads of the circuits are known; the general case is a ground somewhere, which should be tested out and removed; this the ground detector should show.

There is an occasional case of sparking from a broken coil, which can be readily detected by holding a file or screw-driver between any two pole pieces; the tool will be dragged in the direction of rotation whenever the broken coil passes. The repair consists in winding in another coil. A similar case is abrasion of armature coils; if the damage is slight it can be repaired with tape and shellac; if serious, a new coil must be put in.

Improper adjustment of the brushes is a common cause of sparking on board ship. It is intended that the connection be-

tween brush and commutator shall be a rolling and not a friction contact; this is a little difficult to explain, but can be demonstrated by trial.

A rolling contact can be assured by keeping the brush carefully trimmed to the angle at the bar and setting it with a light, complete touch. A brush jig is always furnished, and it is only necessary to file the brush to the exact bevel of the jig. Gauze brushes will seldom spark under these conditions. They are the only brushes worth trying; this of course does not apply to slotted core machines, in which carbon brushes are practically a necessity. A material assistance to good working between brush and commutator is the use of a little oil, that which can be taken from an end bearing on the finger, preserving that smooth, dark-brown color on the bars which is the best evidence of good working.

It is not rare aboard ship to see brushes bent by pressure, producing friction and wear on the commutator, the small area at the heel of the bevel making the contact which may not spread across the space between the bars, and causing sparking which is to be relieved by more pressure; this pressure, assisted by sparking, has one sure result, the scoring of the commutator or flats, both of which tend to farther and more severe sparking, and can be remedied only by dressing down the bars.

The proper trimming of brushes is much neglected; brushes require careful inspection to see that the contact is not ragged, scored or dragging shreds of waste.

Low Voltage.

The voltage of a dynamo for a unit of time is equal to the product of three factors expressed in the formula:

$$E = CNR,$$

in which

E = Total E. M. F. of the generator.

C = Number of coils in the armature.

N = Total number of lines of force passing through the armature, *i. e.*, the intensity of the magnetic field.

R = Number of revolutions of the armature, also of the engine in direct connected sets.

This formula affords us an excellent means of tracing faults in voltage.

The quantity C, the number of coils, is fixed by the design, leaving R and N, the speed and strength of the magnetic field, as the variables. The revolutions are tested by applying a tachometer to the end of the shaft and can be regulated by the governor to the rated speed (usually 400 revolutions); R then becomes a constant and the fault must lie in the field.

The intensity of the field depends upon the number of ampere-turns, which is equal to the number of single coils around a core multiplied by the current passing through the coils. Since the number of coils is fixed by the design, there must be a fixed number of amperes for any given strength of field. The problem thus becomes one of current alone, and shows that low voltage depends upon the simple principle that some by-pass is robbing the field coils of their due proportion of current.

There are several causes of weak field which are beyond the control of the shunt rheostat, or regulator as it was formerly called.

1. *Loose connections or bad contacts.* Every bolt and nut and screw which has anything to do with the shunt or series coils, and at the rheostat, should be slacked up, dirt and oil cleaned away and the contacts brightened up with sandpaper. All should then be securely set up.

2. *By-passes and grounds.* These occur from a collection of dirt, oil or water, or any combination of them, which can form a train to a neighboring wire or the metal parts either about the machine or rheostat.

A case of low voltage occurred on the Columbia which was finally traced to a train of copper dust and filings leading to the shunt field connections. Cleanliness of engine and dynamo should be rigorously exacted; it applies with especial force to motors.

There is an especial case of ground of the shunt rheostat which is a common cause of low voltage. Fig. 20 shows the shunt rheostat complete and also with the brass case removed.

A coil of "resistance" wire is wound continuously on each of two metal frames, as shown at A, the coils being connected in parallel to one of the shunt wires; the other shunt wire connects with the brush B at C.

The brush is insulated from a lever (not shown) which is operated through a rockshaft by the handle D. This brush

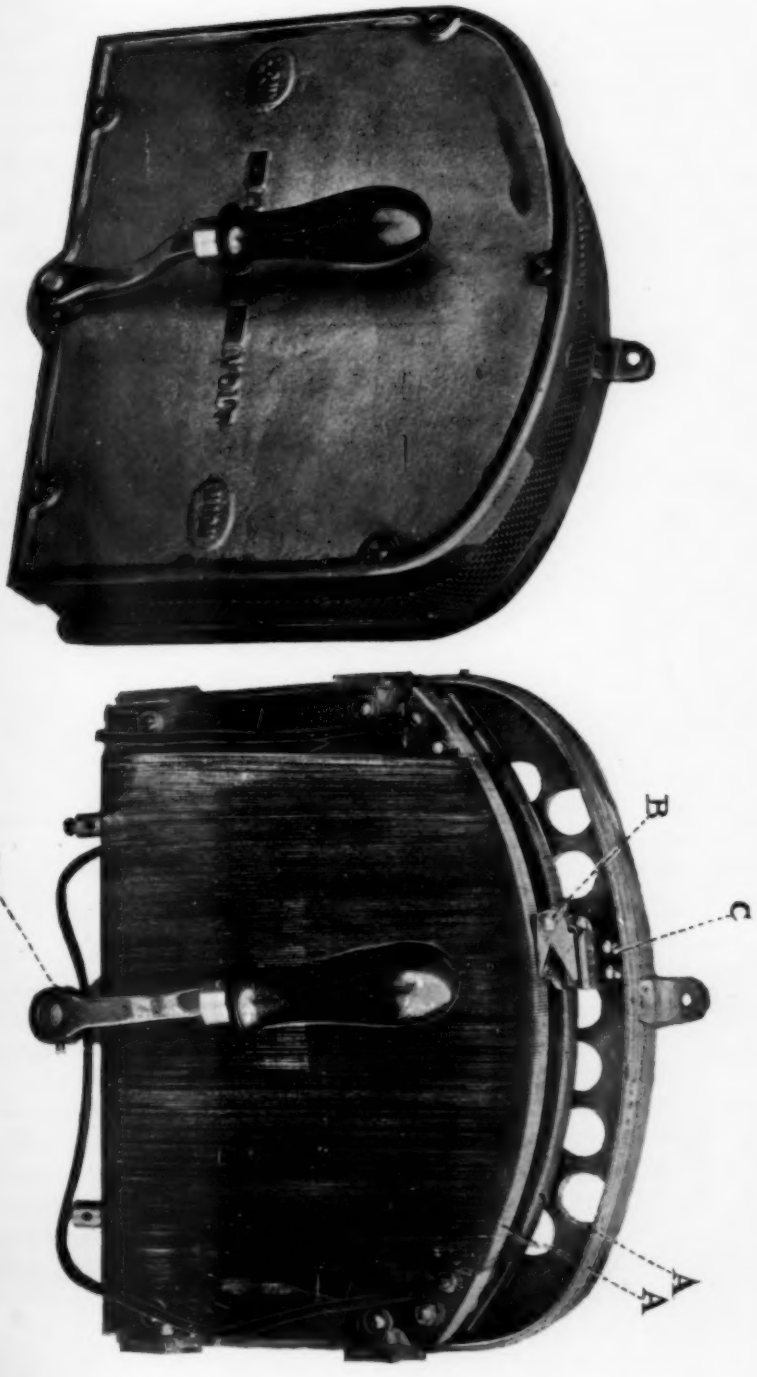


FIG. 20.
Standard Shunt Rheostat.

makes contact with the resistance wire on top of the frame, the wire being laid bare on the upper surface. Though neatly and tightly wound around the frame, the wire is likely to bulge after a time, be touched by the lever on the inside of the frames as it passes to and fro, and be chafed until the insulation is cut through and the wire grounded on the lever.

A sheet of mica or thick paraffined paper will remedy the difficulty until new wire can be obtained for rewinding the coils.

3. *The series shunt.* The office of this device, commonly but erroneously spoken of as "the compounding," seems to be little understood.

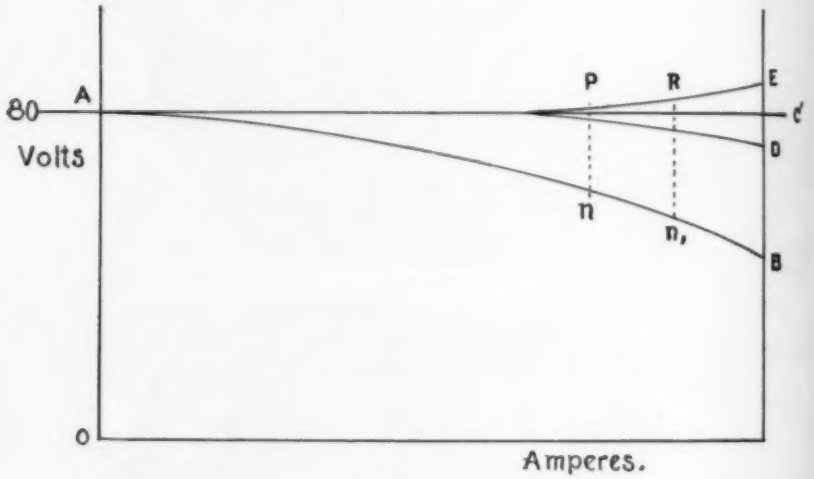


FIG. 21.

A short explanation of the effects of the shunt and series coils and of the series shunt on voltage will make the subject clear.

Fig. 21 represents a theoretical characteristic (the "indicator diagram" of the dynamo) of a compound dynamo in which the ordinates are volts and the abscissae amperes. In starting up—since no current is passing in the external circuit and hence none in the series field—the voltage is raised by the shunt field alone, hence all curves originate at *A*. Were the shunt field to continue to act alone (we will presume there is no shunt rheostat) the curve produced would be *AB*, which curve indicates that the voltage of an unaided shunt field falls as the load is increased, and at full load would be insufficient for anything but redness in the lights. The desired curve is the line *AC*, but as a matter

of experience engines tend to slow at high loads, producing the curve *AD*, and for that reason a slight up-curve, as shown by *AE*, is preferred to *AC*. To supply the increments of voltage *pn*, *p*, *n*, necessary to bring the voltage of the curve *AB* to that of *AE*, is the function of the series field. The action of the combined fields makes the dynamo compound and self-regulating.

It is mechanically inconvenient, if not impracticable, to obtain

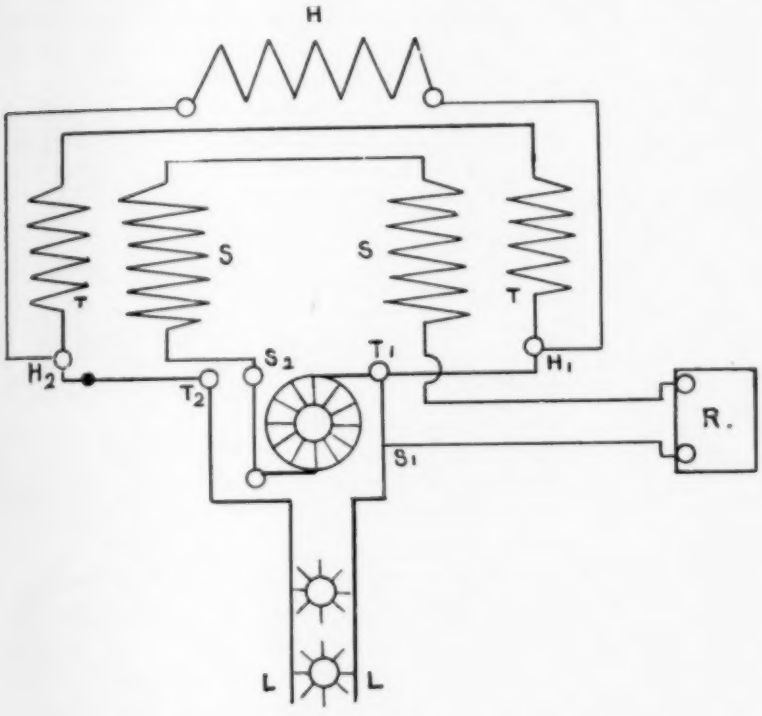


FIG. 22.

those nice lengths and resistances of series and shunt windings which are the necessities of the case, and coils are cut to lengths convenient for construction; the series coils are designed for less than the required resistance, and a series shunt is connected across the terminals of the series fields to afford a shunt or by-pass for the current to be abstracted; the shunt rheostat regulates irregularities of resistance due to original construction, temperature, etc.

Fig. 22 shows diagrammatically the system for both fields. LL is the external circuit or line; S_1 and S_2 the terminals of the shunt field S; T_1 and T_2 are the terminals of the series field T; H_1 and H_2 the terminals of the series shunt H. It will be apparent that any current in H does not pass through T, but goes out to the line through H only.

The actual series shunt is sketched in Fig. 23. It is usually located on the back of the head-board, with a removable cover whose top is made of wire gauze. It consists of copper strip

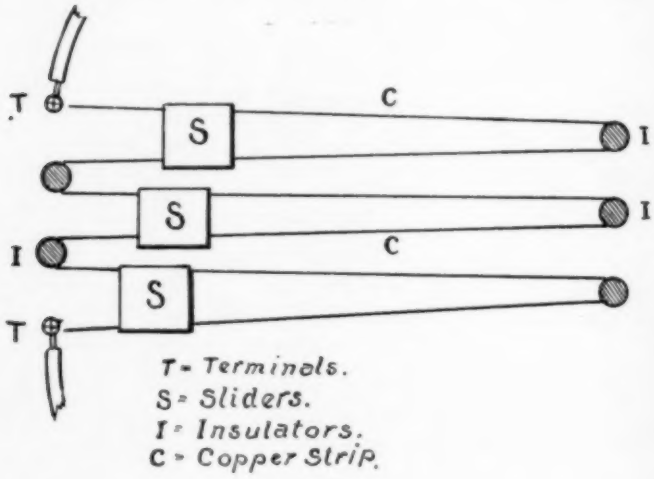


FIG. 23.

zigzagged around insulators A, on which clamp-sliders, Fig. 24, are placed. By moving the sliders to the left the resistance of the shunt is decreased and more current is taken from the series circuit; by moving to the right the opposite effect is produced.*

The series shunt is adjusted on acceptance test and it is not expected that any alteration should afterwards be made or necessitated.

* Left and right here refer to the figure only, the terminals being on the left. In actual machines the location of the terminals is determined by convenience. In narrow dynamo rooms like those of the Boston and Atlanta the generating sets must be installed end-to-end in order to obtain room, and in this case one armature would turn right-handedly (with the sun), the other left-handedly, and the terminals would be different.

On acceptance tests, immediately after taking the cold resistances, the sliders are clamped to the series shunt, preferably midway from the terminals; the rheostat handle is set midway between high and low, or on the middle point or block of circular type rheostats, these midway positions affording the greatest range of control of regulation. When the machine is started the voltage is adjusted to 80 volts by the series shunt sliders for the heat run of four hours, and then adjusted for a full due while the machine is hot. The sliders should be on the same line and a permanent mark made on the case to indicate the proper position. Usually a machine which develops the proper voltage both at full load and no load will produce that same voltage at any other load, that is, within the limits of a volt on either side; anomalies occur.

In a 2-K. W. machine tested last winter, having no series shunt, the voltage at full and no load was exactly 80 volts, but

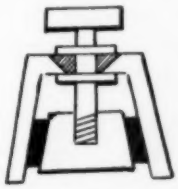


FIG. 24.

at six amperes the voltage increased to 90. In testing engine regulation with this machine the voltage reached 110 when breaking from full to no load in one step; this would be sufficient to burst every lamp in circuit. In a 24-K. W. set tested a close regulation to 80 volts occurred at full and no load, but increased to 89 volts at half load; adjustment of the series shunt brought the characteristic nearly to the ideal over the whole range.

No harm can come of readjusting a series shunt (unless it be overlooked in paralleling machines) if only it is done intelligently; at the same time it is a bad school for dynamo tenders. Nor should an occasion arise until, in old age, the machine develops erratic action which the ordinary expedients will not reach.

The foregoing explanation demonstrates that the voltage of a machine is easily deranged by tampering with the series shunt. This has been developed in the case of a ship that came to the

Navy Yard with an apparently inexplicable case of low voltage. Connections were overhauled, grounds tested out, shunt rheostat examined, and all to no purpose; finally recourse was had to the series shunt, and the sliders found to have been shifted by a man who, in cleaning out some oil and dirt, had moved them and put them back as nearly as he could remember. No one on board had been able to locate the difficulty.

Our dynamo troubles are so few that a little care and intelligence should control them handily, and these qualities will be improved by frequent inspections, above all things for cleanliness.

A certain crack ship in the service had a dynamo room whose bright shellac and general condition would please the eye of any captain; when it came to repairs there was dragged forth from the spiders, armature body and field coils a collection of oily muck and dirt that could have produced a series of troubles; it had deteriorated the insulations as it was. This sort of cleanliness does not, as far as electricity is concerned, partake of any approach to the godliness mentioned in the adage.

Lack of cleanliness, and salt water are the inveterate enemies of electricity on board ship.

One of the difficulties in design of armatures and field coils is obtaining good radiation of the heat generated in the coils. Heat not only increases the coil resistance, occasioning the waste energy of internal losses, and hence decreased efficiency, but deteriorates the insulation of the coils. The non-conducting property of insulation dictates that it be reduced to the lowest advisable thickness; at the same time there is a limit of reduction which it is not safe to pass; our restriction that the heat rise in the coils shall not exceed 50° F. above that of the surrounding atmosphere after a four hour run has necessitated a large armature comparatively; the necessity of this limitation is apparent when we consider the high temperatures of the average dynamo room and the influence of the ultimate temperature to which the coils will be subjected. Oil, in addition to its evil effect on rubber and dirt, increase the difficulties of non-conduction in their cycle of effects.

In some ships *paint* has been put on the end conductors for appearance' sake, a material more baneful to armature coils than oil and dirt, not only on account of the deteriorating effect of its oil on rubber, but through the non-conducting layer established;

once applied it cannot be removed, and when dirty is to be cleaned by another coat of paint, producing more resistance to radiation.

When an armature burns out the accident usually occurs, from a variety of causes, at these very end conductors.

The end conductors of a ship in the service were painted blue; the men of a rival ship, consumed with envy, painted theirs green.

A plea is entered here for more frequent exercise in paralleling.

A veil of mystery and danger is thrown around the subject which it little deserves. Compound machines are paralleled everywhere in this country now-a-days; they will not do it in Europe. But it was not until an electric light station became practically wrecked in New York that our best experts found the solution; they now run the negative leg straight, fuse the equalizer and put an automatic circuit breaker on the positive leg; a machine can be in no danger with this arrangement.

Paralleling compels a man to know his machine or trouble ensues.

The dreaded danger lies in the fact that if one machine A gets a certain increase of voltage over the other machine B, A will cause B to reverse and the whole load will fall on A; B becomes a motor and is likely to rip out its brushes, if of the ordinary copper type, when turning backwards; if the current thrown on A is over 50 per cent. above A's rated capacity, A's armature will probably burn out. This is a rather startling array, but is quite within control when the conditions are known, so much so that commercial machines run along in parallel for hours and days together without a thought of danger, *but they know their machines.*

Reversing an armature, and therefore paralleling, depends on the internal resistance, and hence upon the efficiency; the lower the internal resistance, the higher the efficiency, the less will be the voltage to turn that armature backwards. Taking a characteristic by noting the voltage for each load thrown on, no change being made in the shunt rheostat, will show whether the two machines differ sufficiently, at *any load or loads,* in their voltages to endanger the lower machine's reversal. With our machines there is little chance of it; they are compounded very closely to the straight line, and have characteristics so nearly similar that the matter can be taken on trust, but this does not mean that

it is always to continue so; a characteristic should be taken from time to time to see that it is so.

As long as the difference of voltage does not exceed three (3) volts everything is safe, but the voltages should be kept as nearly as possible to the standard by the rheostat to ensure safety.

First see that both machines are poled right; being in alternate use the voltmeters ought to be connected right and would tend to move in the wrong direction, would not indicate, if the poles were reversed; get both machines up to 80 volts and divide the load as equally as possible between the machines, then close the equalizer switch, called in the instructions the multiple switch. (See Appendix A.)*

Each machine will take up half the load and both will run along practically synchronously and need only the attention of a motion of the rheostat handle now and then. It is better to parallel two machines than overload one, and it is good practice whenever heavy loads are to be carried. It is better not to put motors carrying variable loads on the same bus bar with lights, as a flickering is sure to occur; and for the reason that the mushrooms of a search-light occasion sudden jumps of current within wide ranges, that light is preferably to be run by another machine.

Vibration.

The vibration of a generating set in good working order is purely a question of foundations; with well braced decks, bed-plates resting on two inches of oak to cushion the tendency, and thorough bolting, the difficulty is rare. Two service examples will illustrate the fault.

In the Columbia the dynamos rest on a light deck over a very

* As long as the characteristics of the machines are practically the same it does not matter whether the equalizer is closed first and the circuits turned on, or the circuits divided equally between the machines before the equalizer switch is closed; the above is the method prescribed by the Instructions in the Electrical Journal of the ships and, of course, is official. It is beyond doubt the safer plan for the reason that, having divided the load beforehand and adjusted the voltage for that load, no change in the voltage of the machines can occur, as it might if they were allowed to adjust the loads for themselves, that is, provided the loads remain constant; if they do not and there is any difference of potential created by the extra load sufficiently great to be critical, reversal will occur.

Safety lies in keeping the characteristics the same for all machines at all stages of load and keeping to the instructions implicitly.

high coal bunker. Sufficient support is given by stanchions in the bunker, but no lateral strength is afforded other than that of the deck framing.

So great was the vibration produced that the captain could not write at his desk until the engine was slowed to 350 turns; the greatest obtainable voltage at this speed was 70, the lights showed a bright red.

Four heavy stanchions for each machine were securely bolted to the deck and to the protective deck overhead, with flanged toes bolted to the bedplate. This expedient checked all vibration.

In the Amphitrite vibration was partially remedied by shoring up the deck underneath. The vibration still exists to a marked extent, as any one can testify who will stand on the port side of the quarterdeck or take hold of the bridge rail.

As a matter of physical interest it may be mentioned that in both of these cases distinct nodes and loops were developed. In the Columbia the captain's desk was near the center of a loop, and hence received the full amplitude of the wave.

Noise.

Many noises which occur have been mentioned; generally speaking, none should be allowed to exist.

Piston valves develop a little pounding, due to wear, by balloting against their seats; oil will delay its occurrence. There is a very good valve in the market whose wear is as regular as that of the D-slide valve, and whose wear rather enhances its fit; it is known as the telescopic valve. It will operate even with the valve chest bonnet removed, and has the distinct advantage of acting as a voluminous relief valve in a critical case of water in the cylinder.

There is a noise peculiar to cylinders explained as a combined whistle and grunt. It is due to the friction of the piston, and is quickly relieved by a little oil in the steam. Pounding in the cylinder is generally due to water; if free of water it is good evidence that the load is not evenly distributed between the cylinders and that the valves need resetting.

Reducing Valve.

The frequent complaint against these valves is that they are not adjustable. A gauge with its branch to the steam pipe would

be a great convenience and assitance as showing the actual pressure of steam delivered to the dynamo room. An adjustable reducer is in a sense a throttle, and will produce the evils of throttling down if so used.

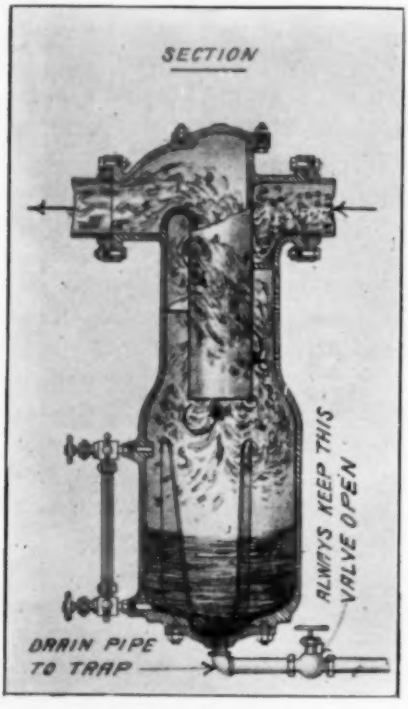


FIG. 25.

Stratton Separator.

Separator.

The Stratton pear-shaped design, shown in Fig. 25, is that ordinarily installed; there is also a cylindrical type. They work well if properly handled, and can be highly recommended. Those furnished have been too small; the rule should be that the capacity should be from four to five times the volume of the cylinder, in order to cushion the engine pulsations and avoid the objectionable vibrations of the pointer of the steam gauge dial. A large capacity separator will also take care of much of the water which comes over to the cylinder on that critical occasion

when a machinist shifts from one boiler to another without sending word to the dynamo room beforehand.

The breakage or blowing out of water glasses is a common case. In some cases it is due to accident, but is more often due to poorly annealed glass. Any effort to work a separator without a water glass is merely courting accident; it was the occasion of the breaking of a connecting rod and the four stanchions of an engine in one of our ships.

The glasses furnished to the chief engineer are trustworthy, will fit, and will be found to last for long periods.

There is a point about separators which has come under observation and which has a bearing on occult cases of water in the cylinder.

The separator is a condenser; owing to the fact that the trap sometimes—though rarely—gets out of order, or needs cleaning, the water is drained through a pipe leading directly into the dynamo room. The dynamo watch can make use of this connection for the purpose of obtaining an odd bucket of water or two; it is a case that can be remedied best by some vigorous administration.

The Switchboard and Circuits.

Before entering upon faults in this direction, and which have been covered in specifications, it may be well to consider the unsettled problem of the behavior of our installations in action. Circuits are now installed to the greatest possible extent below the protective deck or behind armor, exposed branches are run in the most direct manner feasible, and all lines that could be reasonably exposed to the action of shot and shell or develop grounds that would affect or derange the working of any electric light or device needed in action are provided with cut-outs where they do not connect to the switchboard.

Lieutenant W. S. Sims, U. S. N., in a report made on the battle of the Yalu in 1894, says:

"Captain James" (now retired, but formerly connected with the Japanese naval establishment) "says that long before the end of the engagement every electrical communication in the Japanese vessels had entirely failed; that candles and lamps had to be used in all lower compartments, engine rooms, fire-rooms, bunkers and magazines; that the search lights were useless; and

that, fearing the torpedo boats, they were unwilling to risk continuing the action after dark. It is not clear how the electrical communications were damaged, but it is said to have been due to the large and complex vibrations set up in the ship by the discharge of the heavy and secondary battery guns and by the impact of the enemy's shot. It is said that the lights were at first fitful and finally failed entirely."

No more succinct information has been obtained as far as is known.

The responsibility for the results reported has been laid by a high naval authority upon the dynamos, their method of installation, and the circuit appliances in use.

Applying the experience to our own case, we have little to fear from our machines or their installation, excepting as regards location. It has often been pointed out and urged, and becomes more pertinent day by day, that ships, especially battle-ships, should have their plants divided between two dynamo rooms widely separated in the length of the ship.

It needs no argument, but is for some reason completely ignored.

It may be an open question whether our switchboards and the porcelain insulating blocks of wiring appliances—feeder boxes, junction boxes, switches and the like—will stand up under the shocks and vibration of the Yalu report, especially under a heavy shock within the ship.

The panels of the switchboard are of slate, a fairly fragile material, and have many perforations for the circuit leads which increase their weakness; still slate has a distinct advantage over marble, from the diagonal nature of its cleavage. To the very fragile nature of porcelain for insulating blocks is added the fact that the holes for the screws which hold the electrical connections to the blocks are near the edges and corners of the block; the blocks are most likely therefore to break at these screw-holes and release the connections; mere hammering on a bulkhead where wiring appliances are installed is often sufficient to break the blocks.

It is submitted that these loose and vibrating connections, the possible contact—particularly a vibrating contact—of connections of opposite polarity to make short circuit, and the jarring together of circuit connections at the switchboard to cause grounds and

by-passes, will occasion that very flickering and failing of lights spoken of in the report.

It is now required that each panel of the switchboard shall be held by a separate framing of oak—like a picture in its frame—which will afford more security.

The certain safeguard is to make the switchboard panels and insulating blocks of a strong, tough insulating material which will minimize all liability to breakage. Fibre and vulca-bestin (a vulcanized mixture of asbestos and rubber composition) have been suggested, but both are disposed to absorb oil and become poor insulators. The material *par excellence* is micanite; mica would be preferable, but cannot be obtained commercially of sufficient size. Micanite is manufactured by pressing together thin, formed pieces of mica laid in cement; any desired form and thickness can be obtained. Micanite has the objections that it splits, scales or becomes ragged, but these can be prevented by casing or facing with some insulating substance, vulcanized rubber composition for example.

As for search-lights, the exposed condition of their leads almost ensures that they would be destroyed within a short time. In a day action the projectors would be sent below; the leads should have a connection installed behind armor to which loose wires could be connected when needed for night use, and when the projectors can be mounted for use; the subject has not been taken up thus far.

The general excellence and convenience of the present switchboard design, except in so far as the material of the panels is concerned, eliminates it from the question of faults; some changes or rather additions will have to be made, however, to accommodate it to the use of the number and variety of power circuits for which no design has as yet been presented. Small motors can be grouped on lines from the ordinary switchboard; others will probably have panels and circuit connections of their own, carrying knife switches and automatic circuit breakers similar to those used in electric light stations.

The automatic circuit breaker consists of a double pole switch which closes against a strong spring and is held to its closed position by a spring catch. A solenoid adjustable for the permitted overload actuates an enclosed plunger which trips the catch and the switch flies open. Differences in design arise

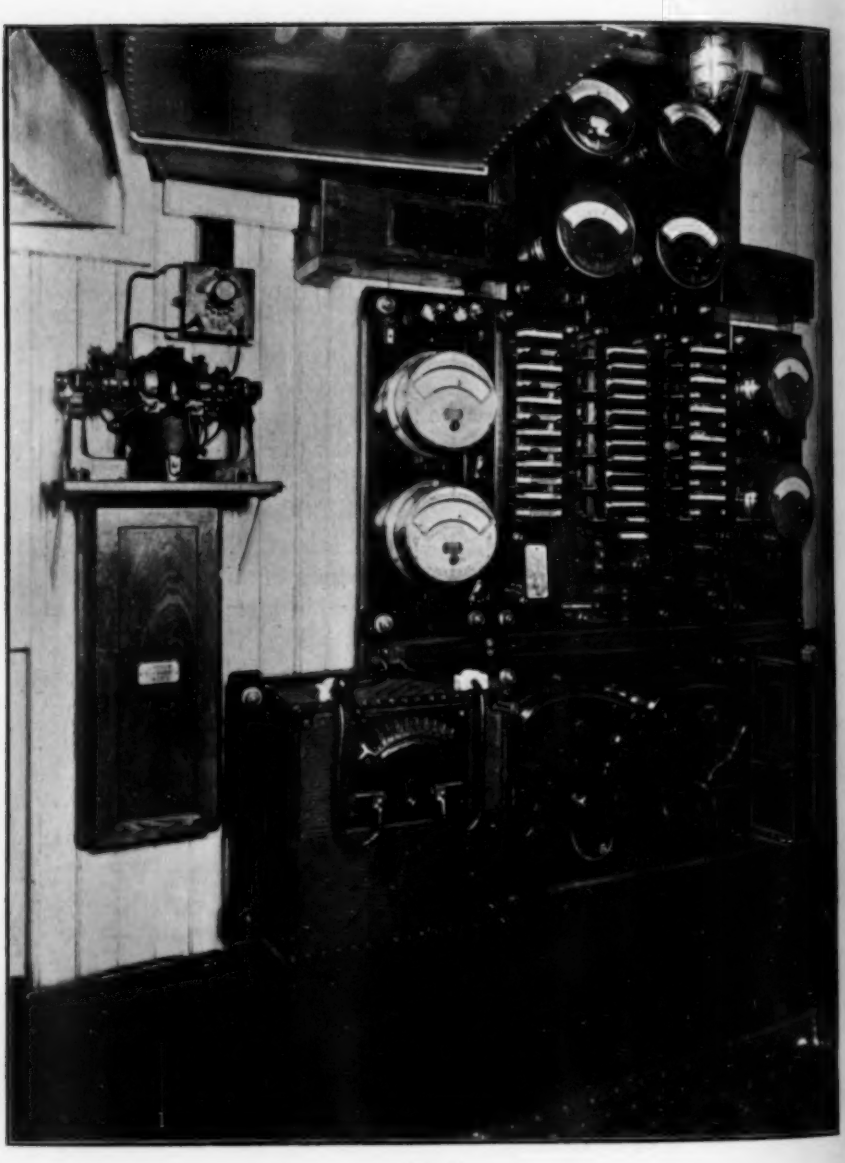


FIG. 26.

Puritan's Switch-Board.

chiefly from the manner of extinguishing the heavy spark at break. In the "I. T. E." design a block of carbon is fitted to both the switch tongues and jaws, the blocks extending far enough to preserve a contact after the tongue and jaws have separated. The resistance of the carbon somewhat reduces the spark, which at the end acts on the carbon alone and not on the copper connection. The carbons can be readily and cheaply renewed. In the General Electric Co.'s design an electromagnet is placed near the sparking contact and breaks the spark by drawing it aside, as in the well known experiment of a magnet on the electric arc; this design is commonly called "the magnetic blow-out."

Automatic circuit breakers are much more reliable and positive in their action than fuses, and, what is better, can be easily tested for operation, which, of course, the fuse installed cannot.

The voltmeters and ammeters are constantly in state of improvement, and even now, wotwithtsanding the excellence of Mr. Weston's designs, which can be safely recommended as unequaled, experiments are making at his works in perfecting the alloys. The circular type of instrument is standard, the ammeters being shunted from one leg of the circuit instead of taking the entire load.

Fig. 26 shows the switchboard of the Puritan. The upper board is for the search light instruments; the boxes for the ammeter shunts appear at the right and left near the top; the transformer, Crocker-Wheeler type, is shown resting on the battery transfer case; the rheostats for the search lights and shunt fields are at the bottom. This switchboard has a position which is very much exposed to particles of oil, when the oil-guard of the neighboring engine is not in place, but no other place is available, one side of the dynamo room having to be left clear for access to the armor bolts.

The lamp ground detector should, and no doubt will, be replaced by the Weston circuit tester and ground detector shown in Fig. 27, which is simply a voltmeter reading both ways from a central zero. The great fault of lamp detectors is that unless there is a *dead ground* the lamp will not flash up; imperfect insulation resistance as low as 100 ohms will produce no indication. In the Weston device lowered insulation is at once indicated by the deflection of the pointer and its direction; it is not

necessary that it should be direct reading, which would occasion expensive design: the deflection is sufficient, the calculation being made mentally or by reference to a table used when testing insulation resistance by the simple, excellent method known as the voltmeter test, to be explained later on.

FIG. 27.

Weston Circuit Tester and Ground Detector.

Many of our switchboards have been insufficiently supported, thereby bringing a stress upon and loosening the circuit connections of the panels. The weight should be taken by a shelf, or at least a plank supported by posts. Accessibility of the connections at the back of the board is imperative.

Safety in paralleling dictates that each set should have its own voltmeter; the practice has been to allow two voltmeters in case of three machines.

Wire. The use of so many kinds and conditions of wire has rendered it absolutely necessary to co-operate with manufacturers and tie down the construction to minute details. Lead covered wire has fallen into disuse from the difficulty of its repair, the manipulation of its weight, and the almost certain breakage at bends and angles. It has fallen far short of the anticipated advantages claimed for its use in heated locations, and is peculiarly susceptible to any electrolytic action; in the underground work of cities where trolleys are run the companies will no longer guarantee it, and lengths have been taken up in Brooklyn on which no evidence of the lead remains beyond a blackish-white salt, due to the action of the trolley currents.

The general principles of construction of standard wire are;

1. A protection against grounds, should the vulcanized rubber strip or flake, by means of a thin layer of pure Para rubber adherent to the copper conductor.

2. Insulation by vulcanized rubber for the voltage to be used. The combined insulation of the two foregoing coats is nearly double that required by the underwriters' specification for 125 volts.

3. Circularity of section over the vulcanized rubber by a layer of cotton tape soaked in an insulating compound, to ensure a neat water-tight fit of the gaskets—the conical, perforated plugs use in the wiring appliances—mere braid forming too rough a surface for the purpose.

4. Preservation of these layers from stripping or flaking off, or from mechanical injury, by means of braid.

A test of the insulating quality of our wire was made by subjecting to the stress of 5000 volts, static charge, which it resisted for nearly an hour. It stood the voltage of an X-ray machine for nearly a minute; this voltage could not be measured but must have been very high.

One great improvement in wire has been the introduction of cables for the interior communication leads by which a few hundred feet will replace the miles of single wire heretofore made necessary. The cable is not only applicable to the bell circuits, but will answer for a number of instruments. These cables are

shown in section in Fig. 28, and have from 2 to 20 conductors. They are installed in the same way as other wire and run into connection boxes taking 20 or 40 wires. Within the connection boxes are the tags for the leads and from them branches can be run to the desired locality by smaller cables, the whole admitting of a thoroughly water-tight connection. A wire in each layer is braided in white for convenience in counting.

An example of some inferior wire which has been used occurs in the bunker and water alarms of the Montgomery and Detroit. This wire is ordinary blasting wire, consisting of a copper conductor and a light layer of vulcanized rubber. Installed over and within a couple of feet of the main boilers the insulation has stripped and flaked, short-circuiting both systems.

Circuits. It may be better perhaps to predicate this subject upon specifications which, apart from the ordinary rules of wiring, have been drawn from experience in service.

"Conduit will be used for all spaces in the water-tight system. It is to be preferred" (to molding) "in all other localities; but in spaces where it may not be desirable to run it over woodwork, as in chart houses, emergency cabins and officers' quarters, standard wooden molding may be used."

Naval constructors define the upper limit of the water-tight system as the stability deck; this would take in all the ship below the main deck and include the superstructure of constructions like the Maine; hence conduit is to be used everywhere, practically, which is not excepted in the specification.

The conduit is iron or steel pipe, brass about the magazines, etc., lined with rubber or bituminized paper; paper is the better for heated locations, such as engine and boiler spaces, drum rooms, etc., rubber where bends and angles occur and where paper would be apt to burr and interfere with drawing the wires.

Molding is open to many objections. It is made of wood, lately expunged from ships as far as practicable; fireproofing is said to detract from the insulating properties of the molding. It requires excessive drilling and tapping of the bulkheads, a screw every six inches of the length, to secure the backing strip of each line run, a serious and expensive delay in addition to weakening the plate.

As the electrical installation must wait upon the other details of construction about the ship, the wiring plans undergo frequent

Conductor Cables. 2-20 Bell Wire, No. 16 B. & S. Scale full size.

UNIT CONDUCTOR.	
Dia. over Copper (No. 16 B. & S., 2.583 cm.)	.05082
Dia. over Para Rubber	.081
Dia. over Vulcanized Rubber	.1425

	CONDUCTORS.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DIAMETERS.	Over Conductors	.295	.307	.344	.385	.428	.428	.471	.515	.559	.570	.592	.604	.629	.648	.670	.693	.713	.713	.738
	Over Tape	.348	.370	.406	.447	.490	.490	.533	.577	.622	.633	.655	.666	.691	.711	.732	.756	.775	.775	.800
	Over Vulcanized Rubber	16/32	17/32	18/32	20/32	21/32	21/32	22/32	24/32	25/32	26/32	26/32	27/32	27/32	28/32	29/32	29/32	30/32	30/32	31/32
	Over Tape	18/32	19/32	20/32	22/32	23/32	23/32	24/32	26/32	27/32	28/32	28/32	29/32	29/32	30/32	31/32	31/32	32/32	32/32	33/32
	Over Braid	21/32	22/32	23/32	25/32	26/32	26/32	27/32	29/32	30/32	31/32	31/32	32/32	32/32	33/32	34/32	34/32	35/32	35/32	36/32

FIG. 28.

Conductor Cables. 2-20 Bell Wires No. 16 B. & S. Scale full size.

changes from the original design and molding lines are turned and twisted for every sort of device or lead of piping; it is too expensive or involves delay to rip out a whole line and re-install, and a makeshift must be designed involving numerous joints and turns, or, in cases where the piping is to set well off the bulkhead, recourse must be had by way of the interior of a bunker, where coal will soon use up the molding; in the New York many of the lines in bunkers are now bare, the molding having disappeared.

The capping warps and exposes the wires; if the screws are placed at the side, much the better plan, there is still exposure at the edges, particularly those of mitred joints. It requires an expensive line of tubes through bulkheads and beams.

Conduit requires only a strap and screws at each frame or about every three or four feet. It can be bent around piping without other support. It can be screwed into flanges at bulkheads and beams without other device. It can be used as a bracket or pendant for fixtures, especially in machinery and boiler spaces, where the use of molding would only admit of the installation of a hand portable. It is available for approaches to the turret leads, where hydraulic power is used, when molding would be inadmissible; within the turrets most of the leads must have a flexible covering, rubber-lined hose or flexible conduit for example.

Some former trials of unlined conduit did not prove satisfactory on account of the effects of condensation. Paper and rubber are non-conductors of heat, and if the original installation is exposed, inside and out, to a moderately cool temperature, the dew-point should be sufficiently low to obviate such a result, and no access of air for a long period of time should afterwards occur provided care is taken to keep the boxes of wiring appliances closed and tight in conformity with their water-tight design. It is from this cause that condensation is most likely to appear; it would ordinarily be trivial in amount and drain into the distribution boxes and be eliminated from there. In repairing a ship 50 caps to the boxes were missing and the boxes found to be filled, choked and short-circuited by a mass of ashes and dirt caked by oil and verdigris, the latter the result of the use of hose in washing down bulkheads. These caps are now fitted with a chain secured to the corner screw of the cover, and not only should the caps be set up hard with a wrench, to prevent tampering with by un-

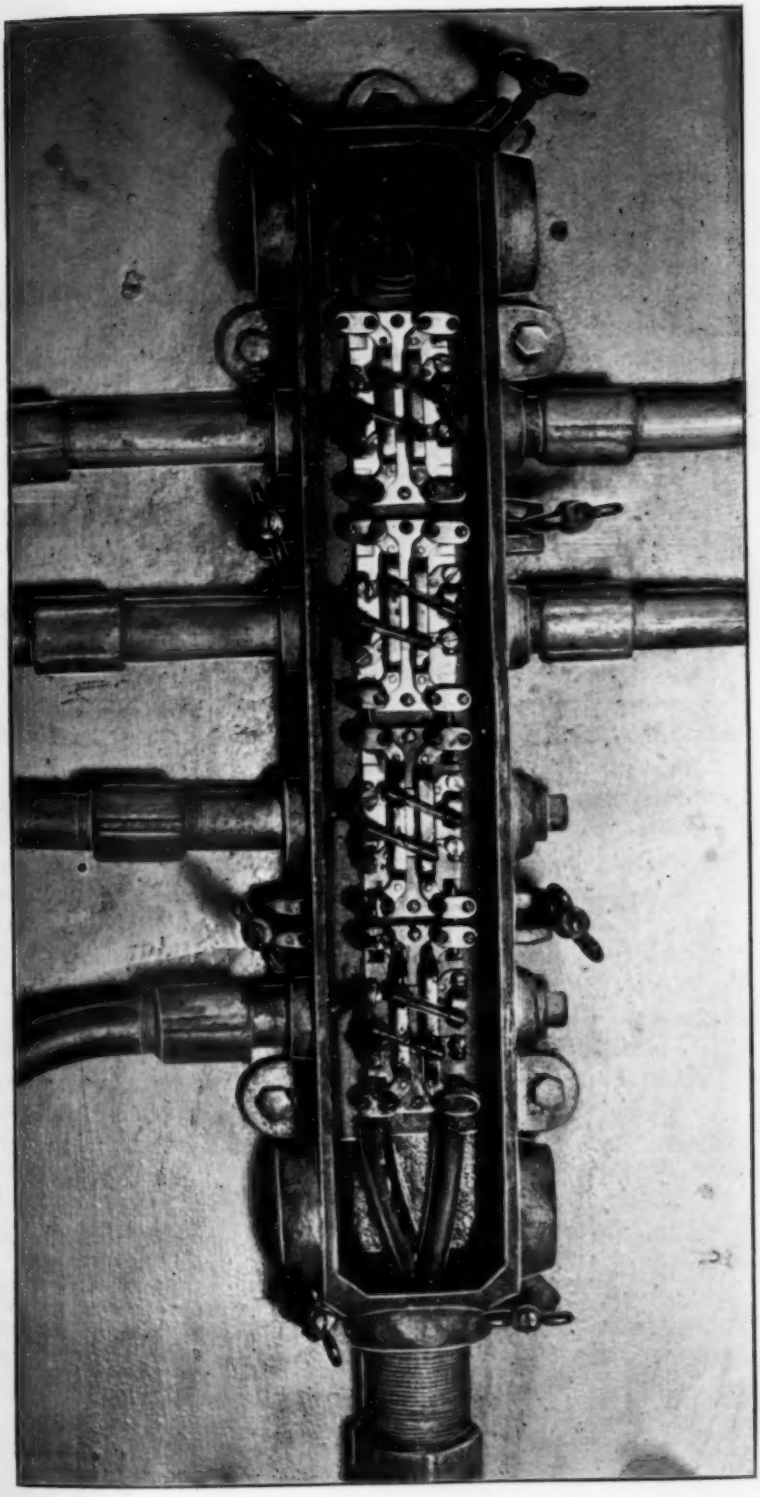


FIG. 29.
Distribution Box from Firerooom of the Puritan.

authorized persons, but the screws of the cover should be set up occasionally to ensure close fit on the rubber washers; the difficulties occur mostly in fire-rooms. Engine and fire rooms are the most difficult to install satisfactorily, and require a good share of attention afterwards.

Fig. 29 shows a distribution box and the method of leading conduit as installed in the fire room of the Puritan. The box is of cast-iron, in which are placed as many of the ordinary interior fittings of junction boxes as may be required for the branches. Bosses are cast at convenient intervals, and those bosses alone are tapped which are to be used for the leads; the branch for a single light would be run in one pipe with double conductor, plain (formerly hemp portable—the term portable is now used for its proper signification of something to be carried).

"Lighting circuits will comprise the following divisions, according to the service required." . . .

These divisions may at first seem complex, but there are really but three sets of feeders, continual service, battle service, and general service, each with its especial variety of lights on mains led off from the feeders or on submains run from the mains themselves. The chief idea is to obtain control of a large number of lights at one point and do away with the endless number of individual switches. Of all our appliances the switch is the most unsatisfactory; the insulating blocks on the stems are readily broken by thoughtlessly turning against the sun instead of with it; the contacts oxidize, heat or are indifferent in action from tension of the springs, thus introducing uncontrollable resistance.

Switches on a battle circuit are undesirable; such circuits should be handled directly from the switchboard to prevent unauthorized lights; the switch and receptacles of the light boxes and a key socket in the armory are all that can be needed. As usually installed heretofore individual switches have been a necessity, but in future installations of battle circuits none should be allowed. The mains for fire and engine room circuits are thrown on through the interconnections.*

* Inquiry has been frequently made for an answer to the examination question, "What is a balanced circuit?"

The technical term of the authorities refers to a balance of resistance as in the Wheatstone bridge, or else to a mere question of polarity, neither of which fits the case. The expression has apparently been coined in the service to mean a circuit which is connected at one or more points to

It is intended that when a loop main is run off there shall be but one loop, the submains to be run off with branches to the lights; the loop-on-loop method involves too many connections when searching for a fault or ground.

The advantage of the loop is shown in Fig. 30. If a set of lights are fed on a main as shown, the farthest lights *B* will not

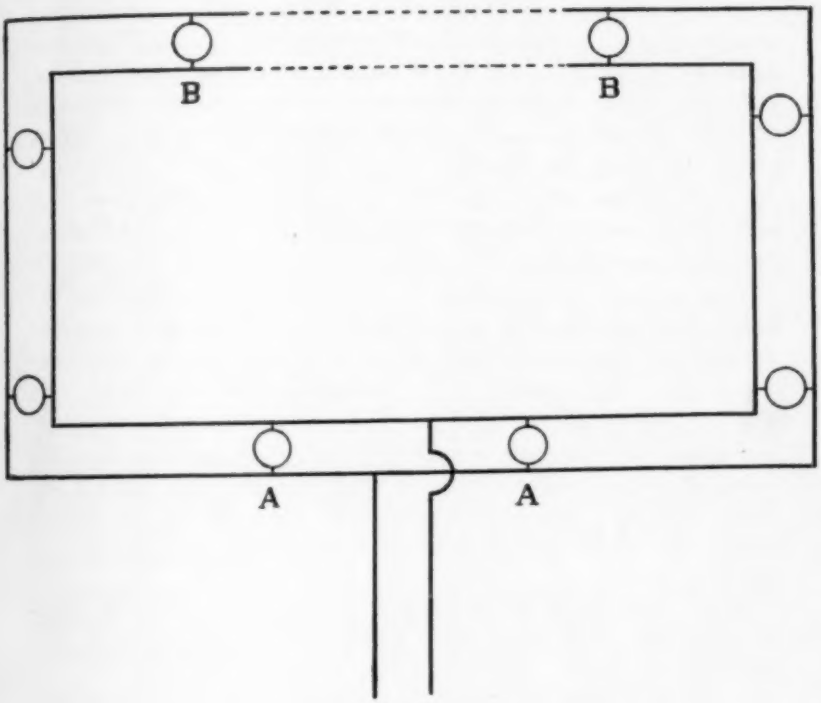


FIG. 30.

burn as brightly as those marked *A* on account of the drop (fall of potential) due to the resistance of the main. If, however, two pieces of wire, as shown by the dotted lines, are connected in, the drop will be equalized all around the "loop" and all the lights will burn with practically the same brilliancy.

The method requires a little more wire than a straight lead

another circuit in order that in case of a break (from shot or otherwise) it will be fed by that other.

Balance as expressed in the question is probably synonymous with interconnection, the present term.

with lateral branches, but in a large crew-space, especially where submains are necessary, the benefits overreach the small additional expense.

"The maximum load for all lighting feeders, excepting those for search lights, shall not exceed 75 amperes. In case the current required for any service exceeds 75 amperes, a sufficient number of separate feeders shall be provided. . . . Motors below 4 K. W. will be supplied by the same feeders, the maximum load on any one feeder not to exceed 75 amperes. . . . No feeder or main will have a less area of cross-section than 1000 circular mils per ampere at the normal load, to be reckoned at the rate of nine-tenths ampere per lamp of 16 candle power. . . . Feeders which interconnect shall have an area of not less than 1500 circular mils per ampere at the normal load. . . . Not more than two feeders shall ever be interconnected, and no feeders shall be interconnected through their mains. . . .

The area of cross-section of the feeders and mains on the *lighting circuits* shall be such that the fall of potential from the dynamo terminals to the *most distant outlet* shall not be more than 3 per cent." (2.4 volts) "at the normal load of the feeder. . . . The area of cross-section of the feeders on circuits for *motors of and above 4 K. W.* shall be such that the fall in potential from the dynamo to the motor terminals shall not be more than 5 per cent." (4 volts for 80-volt circuits, 8 for 160-volt) "at the normal load of the feeder; for other motor feeders to be as prescribed for lighting feeders."

These rules have been revised, and are derived from experience in the great irregularity and want of system in wire sizes and are intended:

1. While limiting the increasing number of feeders by the large load permitted, to regulate the sizes in different ships and still provide a convenient number of circuits for the total load.

2. While allowing full carrying capacity by a stipulation of the number of circular mils per ampere, to prevent wires of undue size, weight and cost from being used by a per cent. allowance for drop. This drop, or fall of potential, is due to the resistance of the lead and is, numerically,

$$\text{Drop} = CR_s,$$

in which C is the current carried by the lead and R_s is the resistance of the lead or section of the line.

3. To prescribe a minimum carrying capacity for interconnections, which has heretofore been more or less disregarded and, in many cases, made through mains whose capacity was much too small, considering the fact that the load of both feeders must be provided for.

The general method of determining wire size has been published before, but will be briefly explained here.

The lights, outlets, etc., are first located and preliminary drawings made for tracing the feeders and mains. In large spaces lighting is based on an allowance of one 16 C. P. lamp for a floor space of one hundred (100) square feet; other spaces are lighted as deemed necessary for their use or for convenience.

The feeder sizes can then be directly calculated on the allowance of nine-tenths ampere per lamp—900 circular mils; a 75-ampere feeder can thus carry about 83 outlets, that is, provided the most distant outlet is not farther from the dynamo terminals than 111 feet.

The general formula for the area of a wire, for any distance, is

$$\text{Circular Mils } (C.\ M.) = \frac{2D \times C \times 10.83}{d},$$

in which $2D$ is the total length of the wire (both positive and negative legs), C is the current to be carried and reckoned at nine-tenths ampere per lamp, a margin of 1¼ per cent. on the actual necessary current, and d is the drop in volts. The formula is derived as follows:

The resistance of a conductor varies directly as the length and inversely as the cross-sectional area (in circular mils by our notation), and is equal to,

$$R = \frac{L \times s}{C.\ M.}.$$

L = Length of wire or twice the distance to be run.

s = specific resistance of the conductor, *i. e.*, resistance of a square inch or square centimetre at unit length at 32° F.

s, for pure copper, is 9.612, and 10.83 at 70° F., allowing 4 per cent. for twist of the strand in the length (properly a correction of L).

Now $d = CR$, from Ohm's law.

Substituting we get the general formula given. If in this formula C is unity and $C.\ M.$ is 1000, $2D$ becomes 111, that is, the

longest feeder line possible at the allowance of 1000 circular mils per ampere is 111 feet; for greater distances the area must be calculated by the formula.

Wiring charts are made up for different values of the variables, from which the necessary size can at once be picked out and that size taken from the standard table which best corresponds.

In order to obtain circularity of section a strand must contain a certain number of wires of the so-called "geometrical series," that is, it must be laid with 1, 7, 19, 37, 61, 91, 127, etc. ($1+6+2x6+3x6+4x6+5x6$ . . .) of the unit wires of convenient size; this is exemplified in the table of standard wires of the specifications.

These wires increase in cost and weight in more rapid proportion than the size, and for that reason a percentage of drop is allowed to keep the size at a safe minimum.

An example of improper wire size is taken from one of our ships in the case of an 8-H. P. motor; the permissible drop at the time was 3 per cent.

The wire size used for this motor was about 350,000 circular mils.

Assuming that 8 H. P. (6 K. W.) was developed by the motor, and the efficiency on terminal energy was 20 per cent., also that the distance was 150 feet, we obtain a wire size of 136,000 circular mils for which the 125,000 standard wire (124,928 actual) would suffice. The size used is then nearly three times as large as it need be, with proportionate great weight and cost. The discrepancy is accounted for apparently by the fact that no drop was allowed for.

Our allowance of 1000 C. M. per ampere provides a large margin; the requirements of underwriters' specifications average about 725. "No tapering to be permitted."

The Tree system of wiring was quite popular at the time some of our former installations were put in. The general idea was to decrease the size of the leads as loads were tapped off to the mains or branches, and thus save wire. But it is an inflexible law of connections that wherever a wire size is reduced a fuse must be inserted, *i. e.*, a junction box, and most of the troubles that have occurred with the system have been from violations of this law. Besides, an overload on the lighter wires has but one result, overheating, ending in fusing or fire. The installation of

extra junction boxes, at $5.60 apiece, brings the cost above that of the safer straight lead at the same size throughout; the fewer the breaks in a line the better.

"There shall be no soldered or other joints in feeders or mains except those made in the standard appliances."

This is to prevent piecing out leads with fag ends and remnants of wire, a too frequent practice in contract ships.

"Fuses for branch junction boxes to be for the normal rated load of 4 amperes, and to blow at 8 amperes."

This specifies the protection to be afforded to branch circuits, and is the basis of construction of the familiar glass tube fuses.

The proper fusing of circuits is more sinned against on board ship than any other repair which is attempted; as long as the original supply of glass tube fuses holds out there is no need for further expedient than merely replacing. When this supply fails those tubes in which the glass has not been cracked by the heat can be made as good as new by putting in a piece of fuse wire from spare stock, being careful to *securely solder* the wire to the brass caps; as practised, the wire is bent over the ends of the caps and no solder is used; the fuse is put in the clips, trusting to the pressure of the clips, vibration shakes it loose and the lights on the branch go out because there is either no connection or that the fuse has blown, owing to the vibratory contact.

When the unfused tubes run short recourse must be had to fuse wire alone, readily accomplished by running one length of fuse wire across and expending the end around the clips. A common, erroneous practice has been to run *several* turns in the figure-of-eight fashion across, thus adding to the carrying capacity of the total fuse with every run; presuming two complete turns to have been made, a reasonable assumption, there would be four runs of wire and the fuse would not blow under 30 amperes instead of at 8, as good protection to the circuit demands.

The use of iron nails for fuses, or rather as a connection, is common in fire-rooms; it usually results in fusing of the clips.

The latest fuse device taken from a ship consists of an ordinary match about which eight turns of fuse wire were wound kite-string fashion; this fuse could scarcely have blown under 60 amperes.

(*To be concluded in No. 87.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SOME ASPECTS OF NAVAL ADMINISTRATION IN WAR, WITH ITS ATTENDANT BELONGINGS OF PEACE.*

By REAR-ADMIRAL G. E. BELKNAP, U. S. N.

Mr. President and Gentlemen of the College:

I appear before you this morning, by request, to read a paper on the subject of "Naval Administration in Time of War," a subject difficult to handle, from the fact that its fullest consideration would perhaps imply a too free discussion at this official place of Department conclusions, methods, and orderings; and if, at times, I seem to stray outside the topic proposed, I but bespeak the indulgence given the parson when he wanders away from his text.

Precisely what interpretation to put on the phrase "Naval Administration in Time of War," is an open question. Wherefore I beg that I may change the wording of the topic considered to this—"Some Aspects of Naval Administration in War, with its Attendant Belongings of Peace"; for this paper will be discursive, historic, and reminiscent, rather than pertaining to departmental methods and the administrative incidents of ships and fleets.

The very able and instructive paper on naval administration—read before the Naval Institute, at Annapolis, in 1888, by Admiral Luce—is doubtless on the shelves of the college library, a work of such thoroughness and grasp that it would be a matter of supererogation to go over the same ground again. And if, in this paper, I seem to differ on one or two points from the conclusions

* Lecture delivered at U. S. Naval War College, July 30, 1897.

of my distinguished friend, the founder and first president of this institution, he will, I am sure, receive with indulgence such differences frankly expressed.

Let me premise here that the bedrock of a naval service is organization; its soul, honor; its necessity, subordination; its demand, courage; its inspiration, love of country; its crown, honor. Wise administration blends all these into one harmonious whole, and makes it an arm of the national defense, superb in its ideal, chivalric in devotion, and invincible in endeavor. To what extent our naval organization and the administration of its affairs have attained to such excellence must be determined by our own conceptions and experiences, present needs and conditions, and by what has gone before.

We are inclined, in our individual lives and personal affairs, to look upon our own geese as all swans, but when, as service men and free-handed critics, we look about us and abroad, contrasting the admiralty doings of other peoples, we are prone to think that other nations possess the swans of naval administration and excellence, while we at times but gather in the geese. Yet if we read the chronicles and histories of the past, whether pertaining to our own or foreign services, do we not find, on the whole, that in naval administration the mistakes and shortcomings of the modern naval world can by no means be all laid at our doors?

We are apt, indeed, to look upon the British Admiralty, its constitution and management, as being superior to the organization of our Navy Department and its systems of administration, but when we carefully consider the different conditions of national environment and political aim that demand our attention, do we not generally conclude that each country best understands the genius of its own people, and in every phase of naval organization and effort adapts itself accordingly?

In a certain sense it is not far-fetched to regard Great Britain as the one power whose commercial supremacy and sea-demand require that the work of her admiralty shall at all times be on lines of substantial naval administration in time of war. In such light, if we but keep our eyes open, we may draw, to our instruction and advantage, lessons of both success and failure. Nor may we forget that the prejudices and political bent of our people look askant at all forecasts of naval administration in the light of war being imminent or actually upon us.

A body of your professional knowledge hardly needs to be reminded that Great Britain maintains two great fleets in European waters—those of the Channel and the Mediterranean—fitted and equipped in all respects, or supposed to be, for instant battle service in whatever waters required. Those fleets, made up of battleships, protected cruisers, torpedo boat destroyers, torpedo boats, gunboats, swift dispatch vessels, and transports, form the basis of England's sea power; and the aim of her admiralty, not always effective, is to hold them at every moment of time up to the standard of readiness and fighting efficiency, without relaxation of effort in anywise.

In addition to these fleets, you will recollect that in January, 1896, a squadron composed of two battleships, four cruisers, and six torpedo boat destroyers, was suddenly commissioned for special service under the command of Rear-Admiral Dale. That squadron was mobilized and made ready for sea—or reported to be ready, if my memory serves me right—in six days. The British people, with pardonable glow, took great pride in such trumpeted, such intended dramatic achievement, while the press of the "tight little island" vaunted with natural exaggeration such significant demonstration of England's readiness for grim work at sea. The date of such incident of naval alertness corresponded with England's flame of exasperation at the tenor of Mr. Cleveland's pregnant message to Congress, a few days before, with regard to the Monroe Doctrine and its application, not only to Venezuela, but to all the states in general on this continent.

When telegraphic announcement was made of the hurried commissioning of that squadron, a reporter of a Boston newspaper called at my home and begged to know what I thought the assemblage of the squadron meant, and its destination. I replied that, in view of England's anger at the President's message, such special naval demonstration was possibly intended as a threat against the United States, or as a notice to Kaiser William—the Queen's British-hating grandson—to keep his hands off from the complications in the Transvaal; but if the squadron sailed under sealed orders, I would not be at all surprised if it was next heard from at Bermuda.

Within forty-eight hours after the publication of such expression I received an anonymous letter from Philadelphia, couched in very bitter language, asking how I could know anything about

the purposes of that squadron and its destination when Admiral Dale himself did not know.

No reply could be made, of course, to a person who was not man enough to avow his name or address; but Whittaker, good British authority, tells us in his almanac for this year that the chief naval event of 1896 was the "sudden commissioning in January, when difficulties appeared to be imminent with Germany and the United States, of a particular service squadron under the command of Rear-Admiral Dale." Hazell's Annual gives substantially the same reason for England's action.

My purpose in recalling to your recollection such naval movement is to bring before you, with unmistakable emphasis, the fact that the particular service squadron, intended by its dramatic assemblage to impress the United States and Germany—as well as the rest of the world—with England's might of preparation and elastic facility for instant mobilization of her fleets, was really in no condition of trustworthiness and efficiency to proceed abroad for war service; for, as the days went by, it was found that ship after ship needed dockyard resort and extensive dockyard treatment, before they could be regarded as in fit condition of equipment and repair to proceed on any prolonged service whatever. Such showing, slowly revealed, called forth pungent criticisms of some of the service papers of England, and doubtless bred smiles and grimaces in the cabinets of Paris, Berlin, and St. Petersburg. It is needless to add that such spectacular squadron never sailed: England, after a brief space of disgruntlement and threat, calmed down; the ships were dispersed in different directions, when they had been made really effective, and Admiral Dale was ordered to haul down his flag and come on shore.

It is pertinent here to cite the further fact that the annual manœuvres of the British Channel fleet in home waters, skilfully and ably conducted as they have been, under conditions as closely akin to the demands of war as possible, have disclosed faults of design and construction, of communication and supply, of seaworthiness and of handling, which England's great naval expenditure, the untiring efforts of her well-organized admiralty, and the undoubted experience and ability of her sea officers have not, as yet, been able to overcome or eliminate.

The lesson we may gather from such showing is that naval

constructors, marine engineers, and sea officers of inventive bent, may conceive hulls, design machinery, and father appliances, which in accordance with the rules of mathematical formulae, promising curves, metacentric heights, and mechanical dogma, may seem to them perfect and therefore incontrovertibly correct; but that the ocean, with its fickle moods, varying conditions, and ruthless tests of sudden gales and blasting seas, but too often tosses aside, with nature's scorn, the conceptions and deductions of men, which in mold-loft and shipyard, in drafting room and machine-shop, in club and cabin, look so fair and promising.

It is a trite saying in the service that "you never know a man until you sail with him." So, too, despite oft-mistaken theory, mathematical demonstration, and professional observation, you never know what a ship will do at sea until old Neptune has plied his buffeting hand and given the verdict of his finding as to her qualities, and the seal of his approval or disapproval as to her merits or demerits.

I am reminded here of the story of the Pawnee, which vessel did such excellent service in inland waters in rebellion days. She was built during the closing years of Mr. Buchanan's administration. Mr. Griffith, her designer and contractor, had proved to his own satisfaction, by mathematical formulae and shipbuilding experience, that with her double bilges, like the rear of the commandant's house at Boston Navy Yard, great beam and light draft, she would make the steadiest gun platform ever devised for sea use; that her motion would be so slight, so easy and steady, that the veriest landlubber who ever paid tribute to old ocean could never get seasick on board her.

The Department, impressed by his ideas, and possibly with an eye to political effect, allowed Mr. Griffith to build the ship, under the provisions of law and contract. In due course she was ready for her trial trip. With light heart and unabated confidence, Mr. Griffith embarked, to demonstrate his conquest of the vagaries of the sea, as conceived in the dreams of his shipbuilding soul and embodied in the Pawnee's double bilges. Commodore Pendegrast, the commandant of the Navy Yard, Philadelphia, a distinguished officer of his day, accompanied him, as well as the naval constructor at that station, and other personages not altogether ignorant of salt-water surprises. All went merry as a marriage-bell while going down the Delaware, but no

sooner had the ship got outside the capes than a gale of wind overtook her, and before the party on board could fully take in the fact, a heavy ground-swell sea was making, which in a twinkling threw the designer and cannot-roll theorist, Mr. Griffith, into the lee scuppers, which he was but too glad to seek, for nameless relief. The naval constructor fared no better, and even the salt-seasoned old commodore and veteran petty officers and seamen had to acknowledge that their legs and stomachs had never encountered such astonishing tests before. The launch, secured on deck amidships, was torn from her lashings and hurled from her cradle by the quick, violent motion and jerky rolling of the ship, and everything movable was tossed and thrashed about in the same exceptional way.

When I entered the service in 1847, the naval elephant in evidence and supreme demonstration of the fallacy of theory alone was the steamer Alleghany. She was an iron paddle-wheel vessel, built on the designs and under the supervision of Commander William T. Hunter of the Navy. Her paddle-wheels were fitted horizontally into recesses of the ship's hull below the water line. Hunter's idea was to protect the wheels from the enemy's shots, but the backwater in the confined recesses and the boring effect of the shafts upon the lower bearings made short work of his theory. Hardly more than five knots could be got out of the vessel under average conditions, and constant repairs of lower shaft bearing were necessary. After continued experiment, at great expense, she was converted into a receiving ship at Baltimore.

Fourteen years later, under the demands of administrative and service need in time of war, Chief Constructor Lenthall, the ablest naval constructor of his day in our service, affirmed that the Monitor class of vessels, designed and submitted by Mr. Ericsson, was an absurdity and would not float. The tests of sea and battle under grimmest conditions made Mr. Lenthall acknowledge that his pronouncement had been wrong. His conversion, indeed, from his original decision against the Monitor type was so frank and complete that the Monadnock, built on plans and lines of his sanction by Constructor Wm. L. Hanscom, proved to be the best vessel of her class constructed during the war or since. In battle her superior merit was clearly shown; in peace, her voyage from the Atlantic to the Pacific, through

the Straits of Magellan to San Francisco, attested beyond question her prime seagoing qualities—qualities that cannot be successfully challenged at this day. And let it be noted that no abomination in the form of superstructures blocked sweeping seas and burdened her deck.

On the other hand, Captain Coles of the British Navy, who had designed and supervised the construction of the ill-fated Captain, in face of admiralty disapproval but by Parliamentary consent, went down in the ship, giving his life in that tragic way to a theory of construction his fellows had condemned.

But you may ask what has all this to do with naval administration in time of war? My answer is that the Navy Department was organized for war; that it can never divest itself of that quality; that whatever it does, the possibilities and contingencies of war are, and must ever be, its prime concern; that the work of peace is but preparation for war in its every phase and incident; that to know this to best advantage is to be informed as to the mistakes of the past, and to act accordingly.

This naval station, which comprises within its limits and control the three institutions of the Training Station for apprentices, the Torpedo School and Station, and the War College, is a significant illustration of war effort. The Government has not only educated the officers in command and in attendance here to the art of war as it must be practiced on the sea, but it has sent you here to enlarge and perfect your education on special and technical lines, which the continued discoveries of science, the genius of invention, the restless activity of the age in every direction of enterprise and endeavor, and the rivalry and determination of the naval powers to grasp and possess the completest and best of the destructive constructions and appliances that the brain of man devises for war's dire work, make necessary for you to know and enable you to meet.

Nor need I remind you that every vessel of war we send abroad to defend our flag and to represent the dignity of the nation on the high seas or in foreign ports carries within her stout hull and the strong hearts of her officers and men the means and ultimatum of war, for exercise and showing whenever occasion may make demand for them. If they do not, then the money the country has expended on them has been expended in vain, and naval administration has been sorely at fault. There

can be no better maxim, indeed, as to naval policy than this: administer department affairs as though engaged in war. Not indeed on the scale demanded by actually present hostilities, but in scope and conduct vital to thorough preparation and undoubted efficiency—to the avoidance of the hurly-burly and waste that war bursting unexpectedly upon a country invariably engenders. In brief, to so administer naval affairs in peace that simple expansion of organization and method will alone be necessary to meet the conditions imposed at the first tap of war's dread drum. But we know that with us such policy is almost impossible, for under our form of government and its ramifications of political power many constituencies and special interests bitterly oppose all expenditures for naval and military purposes; and, from the conditions and outlook of a score of years ago, the wonder is that we now stand as well as we do as a naval power. On the other hand, if we look with straight-eyed candor and in the spirit of judicial examination into departmental management during the past one hundred years—which practically covers our naval life as a nation—and the results that have been achieved, we cannot but admire the general administration of affairs that has brought so much prestige to the country and such splendid illumination of the flag, which it is your rare fortune to continue to bear abroad as its custodian on the sea and as the staunchest defenders of its honor. But do not forget that such administrative effort was made possible by the splendid work of the matchless seamen who have gone before us.

When we reflect that our system of education, training, and administration has given to the age a Mahan, who by his histories, begun at this college as a series of lectures, has so profoundly impressed the world, and especially Great Britain, as to the supreme influence of sea power as a determining factor in the relations of the maritime powers toward one another, we may well say that in certain aspects we are content. To-day Mahan's name and the story of England's achievements on the sea, so strikingly set forth by his able pen and brilliant scholarship, are more potent in the British Parliament for naval chieftains to conjure with, in support of measures to increase the dominance of the British Navy, than the voice and arguments of any living Englishman. I do not know, indeed, but that our distinguished fellow-alumnus of Annapolis should be court-mar-

tialed for furnishing such aid and comfort to our English cousins in their effort to maintain their supremacy on the sea—a supremacy that we must always regret and which we should always resent.

I wonder what the amiable Cockburn, who in 1814, as a British admiral, took the Speaker's chair at the National Capitol, and after putting the question, "Shall this snug harbor of democracy be destroyed?" gleefully ordered the torch to be applied—would have said could he have foreseen that, before the century closed, the dictum of a Yankee naval captain, as regards the British Navy, would be so eagerly listened to and so closely followed. It is, indeed, a happy fact that democracy has bred on this soil neither an Admiral Cockburn nor a Hudson Lowe, both of infamous memory. England is quite welcome to men of that sort—the products of her naval and military training and administrative methods, which of old were akin to mercilessness.

No graver problems of difficulty and discouragement ever confronted the naval administration of any nation than our Navy Department had to meet in the early days of 1861, when, after a rudderless drifting of some four months toward the rapids of destruction, the country found itself involved in civil war. Up to that period the organization and administration of the Department had been of the simplest character. Its personnel was mostly civilian. Aside from the then five chiefs of bureau, three of them of the line, standing for the military branch, there were hardly more than half a dozen other officers on duty in the various offices. The office of detail was unknown. The Secretary and the chief clerk attended personally to all matters concerning the personnel of the service, the selection of the officers for their varied duties afloat and ashore, and conducted the chief correspondence pertaining thereto. Nor did the incessant demand of the war, and the overwhelming work it imposed seven days in the week, and often throughout the nights, during four long years, seem to make it necessary to increase, to any marked extent, the purely naval branch of the Secretary's staff. True, the office of detail was established, and the office of Assistant Secretary created the moment it was seen that great naval expansion would be imperative, for effective operations against the insurgents, and, possibly, against a foreign foe. In July, 1862, the Bureaus of Navigation, of Equipment and Re-

cruiting, and of Steam Engineering, established by Congress, took from the other bureaus created twenty years before, some of their powers and duties, but such additional division and ramification of administration did not much increase the personnel of the Department, especially as regarded the officers of the service, whether of line or staff.

Now, when we consider the task of the Department in 1861, the obstacles it had to overcome, the work it had to do, and the results it achieved, it must be admitted, I think, that on the whole our naval administration during the four eventful and remorseless years that followed could hardly have been bettered. And in such light, such showing, we may well take lessons for future administrative work in time of war.

But let us not forget how fortunate it was for the service and the country that the Secretary of the Navy at that momentous period was, as a former chief of bureau, not unfamiliar with naval affairs and had large acquaintance with navy men; that the Assistant Secretary, who had resigned his naval commission a few years before to take up civil pursuits, was thoroughly cognizant of service thought and nautical possibilities, as well as the standing and temperament, idiosyncrasies and limitations of his old associates, which, together with the equal knowledge possessed by the detail officer—now for the first time recognized as a necessity and clothed with authority—made it easy, and generally without mistake, to select officers for assignment to the duties they were deemed best fitted to perform, whether in command of fleets or ships, or on other service of whatever character.

In the midst of the most stressful period of the war, old officers of the Navy said to Mr. Welles, "Why don't you relieve yourself of some of these killing details of work and organize a board with powers akin to those of the British Admiralty?" "No," said Mr. Welles, "the law and the confidence of the President make me responsible. Members of boards form conflicting opinions and sometimes block action. Such system would not do for us, especially at this juncture. I am open to fact and argument. When all are laid before me, I can on the instant consider carefully and decide intelligently, and be prepared to justify my action." The Secretary was right. Commissions and boards are a snare. In great executive spheres and posi-

tions of prime responsibility, particularly in naval or military affairs, the one-man power, under the law, is necessary, if we would have efficient working and desired results. Three captains of a ship would make short and destructive work of discipline and purpose, though in these leveling days, tending toward insubordination, much in that line is suggested and sometimes attempted.

Said General Logan, in reminiscent talk of incidents of his service in the field: "General Grant would call a council of war, listen silently in bent, contemplative mood to all we had to say, and then dismiss the council without having said a word as to what he intended to do. The first intimation we would get of his decision would be embodied in orders for our execution, as likely as not to be in utter variance with the opinions we had expressed. We didn't like it altogether, but we knew we must obey."

So, too, Farragut, when he called his captains together before his first brilliant work on the lower Mississippi, and a captain rose from his chair to depict the difficulties of the proposed operatons and to advise against them, the dauntless old Viking broke in with these words, "Gentlemen, I have not invited you here to consult you as to the feasibility of the proposed attack and passage of the forts. My mind is made up on that head and the attack will be made; any suggestions you can make as to the best means of forwarding that movement will be gladly received; I can entertain none other." Ah! that is the sort of men we want Annapolis and Newport to turn out. A man who knows his own mind, has the courage of his convictions, believes in himself, and in the loyalty, devotion, and intrepidity of the officers and men he commands under any circumstances of peace or war. An officer whom to know is to love, whose subordinates, in their great trust and supreme devotion, will follow to the death!

I must confess my regret that, in his lectures here, Mahan did not draw more upon the incidents of naval valor and achievement from the history of his own country. Strategic movements upon land and the controlling efforts of fleets on the sea are, in my judgment, utterly and entirely indifferent. And, as an American, grateful to France for what she did for us in the Revolution, I wish that Nelson might have met at Trafalgar—not a Villeneuve, with his hesitating Spanish ally, his half-hearted

captains and seasick crews, but an officer of Farragut's dash and determination, supported by such able and intrepid captains and officers and battle-seasoned seamen and marines, whose valorous work in gulf, bay and river, led by our great admiral, make such glowing pages in our naval annals. Those gallant souls would have counted it a great joy to meet British seamen under like circumstances and show them the difference between Gallic and Yankee webfoots.

When the Southern politicians engineered their schemes for breaking up the Union they took but small account of the Navy, what it could do in the event of hostilities. Nor did the Southern officers who threw up their commissions show much keener perception. They had not yet learned, after all their association, to know the fibre of their Northern brothers, and what an aroused people, full of the instincts of the sea, could do when confronted by a great emergency. For three months after the tide of secession had set in, our officers and men serving abroad did not know from week to week whether they had any longer a government. The country had but forty-two ships of war in commission of all rates, and all having among the officers—never among the seamen—some who meant to throw up their commissions the moment they could do so. Officers at home—both of the Navy and Army—were sending in their resignations and hurrying South from day to day, while timid souls, weak-kneed politicians, and other frightened folk, losing their heads, begged for a policy that would save the land from bloodshed—even to the acknowledgment of the Confederacy. Meanwhile, British statesmen of the Palmerston and Russell type not only laughed in their sleeves, but openly sneered at the day of Yankee discomfiture and the death-stroke to the Great Republic which had come, as they thought, and they felt happy. The press magnates and magazine seers of England took up the notes of jubilation, and soon, with great satisfaction to themselves, blotted us out as a nation and established from three to five confederacies out of the territory of the United States. But the echoes of Moultrie's guns and the reverberations of Sumter's reply had hardly died away before the entire North sprang up as if possessed with one soul, and said "This thing shall not be!" Across the seas and continents flashed the tidings, stirring the world with sensations it had not known since the outbreak of the French

Revolution. Our citizens abroad dropped their business and hurried homeward to do their duty in defense of the flag, and, swelling the tide of patriotic ardor, came hastening from every sea the officers and men from our then incomparable merchant marine, eager for navy training and service afloat against the enemy.

Then came a great triumph for our system of naval administration—its elasticity for preparation in emergency and its effectiveness for war. Mr. Secretary Welles at once called about him some of the ablest and most experienced officers of the day to consider the situation, formulate a policy, indicate plans of operation, and fix upon the best and speediest means for the building of new ships, the purchase of merchant vessels and their conversion into cruisers and blockaders, the recruitment of officers and men and the means for their training, and the many other incidents of service needs and details of supply that naval operations in war would require.

Those matters duly considered and determined upon, the officers consulted were dispersed to different points to carry out, with the aid of eminent persons in civil life, the measures agreed upon. Under such illumination of purpose and with masterful grasp of the difficulties to be overcome, and an energy and versatility of effort and direction never surpassed in the world's greatest epochs, the little navy, despite the temporary demoralization it had suffered through the desertion of many of its ablest officers, was soon expanded into a great service of frigates and ironclads, heavy and light sloops-of-war, gunboats and supply vessels, of more than six hundred pennants, and a personnel of some seventy thousand officers and men. The officers and men who had volunteered from the merchant service, trained to the habits of the sea, soon became, under special instruction and drill at schools established at the navy yards and stations, and through service afloat, staunch men-of-war's men—who were heard from, to their great credit and valiant bearing, in every naval battle of the war, as well as in the burdensome, harassing duties of the blockade, and every other incident of service belonging to seamen.

Four squadrons or fleets were mobilized in briefest time, and the extended blockade from the Chesapeake to the Rio Grande was established, before Earl Russell had grasped the fact that

no paper blockade had ever been contemplated on this side of the water, of which alone he thought the United States capable.

Fast supply steamers of great capacity were fitted out to traverse the lines of blockade and distribute fresh provisions and other supplies to the ships, convey officers and men, including the sick and wounded and prisoners, back and forth, and to carry mails and dispatches. Sailing on fixed dates from Philadelphia and New York, their service was performed with the regularity of the transatlantic packet service of this time. And when good lodgment had been made on the insurgent coasts where permanent squadron headquarters could be established, the floating machine shop, the receiving and hospital ship, the collier and ammunition supply vessels speedily followed. And, in short, every essential of supply and equipment was furnished with a marvelous foresight and ready facility never surpassed by any naval power.

Would you know more fully what such accomplishment meant, contrast the pitiful showing made by the fleet England commissioned and sent to the Baltic in 1854 at the beginning of the Crimean war. The state of the British navy and the administration of its admiralty were so low and inefficient at that day that the fleet, consisting of fifteen vessels—battleships, frigates, and paddle steamers—was hurried off, incompletely manned by crews so raw and undisciplined as to be almost nondescript. One ship, the Monarch, when reinforcements were to be dispatched, was detained some time because of the mean character of the crew. It was reported, indeed, that "scarce a man on board knew a rope." In all the ships the lack of trained petty officers and men-of-war's men was distressing to those in command, with the responsibilities before them.

When the commander-in-chief, Admiral Sir Charles Napier, complained of such conditions, he was told to fill up his meagre, untrained complements by picking up Swedes, Danes and Norwegians on his way to the scene of action. The attempt to draw men and second and third mates from English merchantmen, to make petty officers, failed utterly. Volunteering to meet an enemy in time of war was an instinct of patriotism unknown to them. Not one officer from England's merchant marine would consent to serve unless assured of permanent place in the Royal Navy. How different the spirit and actions of the men and

officers of our merchant marine in 1861, as already noted. The admiral asking for gunboats and small steamers, for operations in the shoal waters of Cronstadt and other points in the Baltic, was instructed to negotiate with the King of Sweden for the use of his gunboat fleet, and also to be allowed, as a matter of economy, to hire small steamers of Swedish subjects for operations against the enemy; but the King was too wary to put his foot into so clumsy a trap, which would have made him an ally of England and an object of Russia's resentment, to be reckoned with sooner or later. Equally futile was the admiral's effort to make up his shortness of junior officers by the hiring of Swedish officers to serve in his fleet at that juncture. What would have been said of us, indeed, had our naval administration been so inefficient as to have obliged us to attempt to hire foreign officers to officer our ships in rebellion days? What scathing criticisms would have come from John Bull!

Most surprising was it too, when regarding it as absolutely indispensable to exercise his raw crews at target practice, the admiral was cautioned to "be careful in such expenditure of ammunition, because the supply of powder and shot at home was so limited." And this on the occasion of England's last great war with a naval power. Such grave instance of maladministration seems almost incredible, when we know how perfect in every detail and ample in supply was our ammunition under the urgent demands of the war we were called upon to wage so suddenly a generation ago.

It is needless to add that this expedition, so much heralded at the outset, failed most lamentably in its object; but when we read Admiral Napier's biography and letters we must conclude, I think, that the fault lay in the admiralty's surprising lack of apprehension, and its marked inefficiency in grappling with the problem of war and its naval needs for successful prosecution, rather than with the methods of Sir Charles. That distinguished officer, however, on his return to England from his ineffectual campaign—due in part, at least, to admiralty shortcomings—was dismissed from his command, and under such circumstances of discourtesy that another notable flag officer, to whom the fleet's command was offered, promptly refused it on the ground of Napier's treatment, and for the further reason that "he would not command a fleet in which the officers were set to criticise their

admiral." And, says Napier's biographer, "It is a singular, yet incontrovertible fact that every British admiral of eminence, when in command of a fleet, has been subject to the marked enmity and insult of the Board of Admiralty." How close to the truth such averment is, you have but to read the memoirs, letters, and biographies of England's great seamen, among whom may be cited Keppel, Lord St. Vincent, Dundonald, Hawke, Collingwood, Napier, and others, including even their great sea king Lord Nelson.

In our inherited tendency—nay, birthright as seamen—to growl, when we criticise our departmental administration, we have but to look across the water to find doings and shortcomings in naval affairs that have as yet found no place in our annals—whether for corrupt administration or vindictive motive.

Yet our British kinsmen of the sea have this advantage over us, that an officer on the active list of the Royal Navy can take his seat in the House of Lords, or be elected to the House of Commons, and stand up in his place and criticise the ministry and their administration, and denounce what he regards as admiralty shortcomings, as freely and fearlessly as any other member of Parliament, and there is no authority that can bring him to book for it, except through Parliamentary procedure. An officer like Lord Charles Beresford attacks admiralty methods whenever he feels like it, but he is very popular among the English people, and the members of Her Majesty's Government have profound respect for public opinion, especially as ugly questions put in Parliament must be answered.

In this connection, let me invite your attention to an article in the Fortnightly Review for July, entitled "England and the European Concert," written by Captain James N. Gambier, R. N., an article that describes in most pungent terms the shortcomings of the British ministry, in its dealings with the Cretan and other questions of vital import to the British Empire, as one of the great powers not only of Europe but of Asia.

The Queen's age alone seems to spare her from the writer's scathing criticisms, but Lord Salisbury, his temperament and methods, his indecisions and final commitments, are dealt with in the most searching, blunt-spoken, and contemptuous manner.

Were an officer of our Navy so to express himself with reference to the management of our affairs by our President and his

Cabinet, he would be speedily brought before a naval general court-martial for violation of law and regulation; but should an American officer lose his rights and privileges as an American citizen simply because he holds the commission of his Government? The Englishman under no conditions of place or station, circumstance or employment, loses his birthright, which his ancestors sturdily contended for long before the days of King John and Magna Charta—the rights of opinion and of speech—rights the violation of which led Charles I. to the block.

To return from this digression, let us note the fact that in 1856, or just two years after Sir Charles Napier had sailed for the Baltic with his somewhat Pinafore array, the ships of that fleet constituted a part of the grand naval review held at Spithead, preceding the dismemberment of the fleets that had been engaged in the Crimea and the Baltic. Neither fleet had accomplished much in their operations against the enemy, but the combined force of twenty-two battleships, forty-two frigates and corvettes, seven floating batteries, and a large number of dispatch vessels and gunboats, manned, as the Chronicle says, "with 50,000 sailors," made a splendid showing. Yet from what we have noted on British authority as to the quality of the crews Admiral Napier had to deal with at the outset, we may well question the assumption that the "50,000 sailors" of that occasion were seamen in the true sense, though we may not doubt that Sir Charles had "licked his crews somewhat into shape," as the phrase goes, before he left them. The cat was still in lively swing in the British service, and it was a powerful persuader.

Lately historic Spithead has seen the greatest of all its naval pageants. In truth, the smoke of the thunderous salutes, acclaiming the sixty years' reign of the Queen and the pride and power of the British Empire, has hardly yet drifted away, while the press of the civilized world has labored, and still labors, to give adequate voice to the impressions of strength and grandeur which that vast assemblage of ships, that weighty display of sea power, made upon all who had the rare fortune to witness it.

That unequaled display of nearly two hundred pennants, streaming from the mastheads—if masthead is not now a misnomer—of battleships and armored cruisers, torpedo gunboats and torpedo-boat destroyers, and other well-equipped craft for war purposes, showed at a glance and with awesome significance

what those sturdy folk of the British Isles have accomplished in the world's great affairs, and the pardonable pride they take in impressing their great deeds and unsurpassed achievements on sea and land upon the knowledge and mind of mankind; but as British royalty and British statesmen looked upon the short line of foreign ships of war that were present to do honor to the Queen's fete and to the British nation, there must have come a sigh—a pang of bitterness—from many a British heart, when the eye fell upon the flag floating from the staff of the Brooklyn, for that flag represented the majesty of a great people who had broken away from the thraldom of colonial life and the tyranny of the British Crown, and made for themselves a weighty place among the nations; a flag that stood for the wresting of a great domain from the British Empire, and in significance of the greatest defeat in the annals of her imperial policies; a flag which, despite her great sea power, Great Britain must respect, even to the curbing of her aims and pretensions on this continent.

The modern battleship, with her pent-up powers of destruction and wondrous mobility, her intricate mechanism and surprising adaptation of the mysterious forces of steam and electricity, constitutes one of the most daring conceptions of the human brain, among the greatest conquests of man over the secrets of nature. But like God's masterpiece—man—its parts are liable to accident, derangement, and destruction.

Wherefore, when, after the dazzling display at Spithead the other day, a naval authority alleged that "in four days one hundred and twenty vessels of that fleet could be at Gibraltar; that in nine days the Channel fleet, twenty-nine strong, could be at Halifax; in twenty-seven days at Delagoa Bay, and in fifty-eight days at Hong Kong," I am inclined, in the light of experience, to discredit such assumption.

Holiday showing is not to be relied upon; such displays make no test of a ship's efficiency for cruising and for war. Long ocean passages, the encounters of gale and sea, and the rollings and strainings incident thereto alone determine seaworthiness, the reliability of machinery, the stability as to platform for efficient use of the guns, character of steerage qualities and ready handling of the ship in the varied emergencies and demands of salt-water work.

Since Spithead's great demonstration, the Channel fleet has

held its annual manœuvres, and from the reports gathered from the newspapers we learn that the orders of the admiralty were not understood, and that serious accidents have caused misgivings as to the efficiency of the fleet. Among the accidents noted was the scoring of one or more of the cylinders of the battleship Mars and of the cruiser Terrible, incapacitating those ships for further present use. Such chroniclings of misunderstanding, accident, and disablement do not look like nine-day passages to Halifax. They point rather to inefficient management of machinery and weakness of parts. Nor do they compliment the interpretation of admiralty orders, which we should take for granted were intended to be as concise and explicit as the conditions of war and its surprises ever demand.

England, in her mighty efforts to continue her dominance of the sea, conducts these annual manœuvres on a large scale and at great expense. The mistakes she makes brace up her accomplished officers and gallant men to higher effort and more approved methods. She thus helps herself on professional lines and also instructs the world on naval needs and advancement. To profit by her experience and to note her mistakes with careful heed has even been the wise policy of our naval administration, whether in peace or war. Wherefore, what has been said, I submit, has been pertinent to the subject in hand.

But I know no more instructive illustration of brilliant naval administration than Japan displayed in her recent contest with China. Her success was no accident; it was the result of long preparation and thorough organization, well matured and skilfully perfected.

From the moment Japan had fairly entered into treaty relations with the Powers, as the result of the incomparable diplomacy of Commodore Perry and Townsend Harris, and opened her ports to intercourse and trade, she began to think of a navy. And likening her geographical position in the Pacific to that of the British Isles in the Atlantic, she took for her inspiration the island wisdom of England, and set forth with pronounced energy to become a naval and commercial power. She at once established dockyards and schools of training for seamen and gunners, and every class of mechanic or artisan needed on board ships of war at this day. She also organized a naval academy at Tokio for the education of cadets, and arranged with foreign govern-

ments to have some of her youth received and trained to the naval profession at their respective technical schools; nor need you be told that among the most honored officers of Japan's navy to-day are some of your fellow-alumni of Annapolis.

When, in 1889, I first visited the imperial dockyard at Yokosuka, a few miles below Yokohama, I found, to my surprise, an establishment and plant superior in equipment and completeness to any yard we possessed at that time.

Annually, for several years before Japan threw down the gauntlet of war to her colossal neighbor, the Emperor used to assemble the flower of his army and the major part of his fleet and transports on the shores and in the waters of Owari Bay, on the southern coast of the Empire, for inspection and drill, evolution and manœuvres.

There, attended by his ministers and members of the diplomatic corps, and other distinguished personages, the Emperor would pass a week in camp and on shipboard, inspecting and reviewing, and witnessing the manœuvres and evolutions of the army and fleet, and engaging them in mimic war, pitting the one against the other in carefully prepared plans of attack and defense. The embarking and disembarking of troops, the handling of artillery and horses, pontoons and ladders, ordnance supplies and intrenching tools, provisions and hospital fittings, were among the features of the occasion; and no detail likely to be demanded by the necessities of war was omitted. *On the conclusion of such annual manœuvres, all defects disclosed were immediately remedied;* and so it came about that, before the news of the declaration of hostilities between the two great Asiatic powers had reached London and Washington by telegraph, the fleet and army of Japan were already on the move for the scene of operations.

One morning, in 1890, and within sight of the spot where Perry signed his treaty in 1854, I saw a special train from the dockyard at Yokosuka pull into the station at Yokohama, bringing the officers and crew for a new cruiser, then approaching completion at a shipyard in France. As the detachment, thoroughly homogeneous in character and dressed in the neat uniform of navy fashioning, left the train and fell into line under the direction of its officers, with an alertness of movement and readiness of execution that no other service men could have surpassed, and marched to the bund to embark upon a French steamer bound to

France, I was moved to admiration; and I wondered what Commodore Perry would have thought could he have lived to see such incident as one of the significant results of his masterly diplomacy at that historic spot, where all others before him had failed.

I have said that Japan likens herself to England. To be the England of the Pacific is her dearest aim. She is pushing and ambitious, and wishes to become a colonial as well as a naval and commercial power to be well reckoned with. She has already possessed herself of Formosa—an island magnificent in its possibilities. That she has an eye to the acquisition of the Philippine and Caroline islands, the secrets of her foreign office would probably disclose. That her probable wishes in those directions are natural no candid observer may gainsay; and what she aims to do she will not give up, except under circumstances of great stress. Her statesmen are able and accomplished. Bred to arms and of martial mien and spirit, they are discreet but fearless, energetic, farsighted, and tenacious; and so self-contained withal, that no Talleyrand or Richelieu ever surpassed them in the art of hiding in words their real intentions.

In the line of current events, you doubtless have noted what Sir William White, the eminent British naval constructor, was alleged to have said to one of the Brooklyn's officers, when dining recently in his company. "You Americans need to keep an eye on Japan; the Japanese are likely to give you trouble," was the pregnant remark of Sir William. Then allusion was made to the advanced state of the heavy battleships Fuji and Yashima, building in England for Japan's navy, and how readily they could proceed to the Pacific, if occasion demanded their immediate departure. Doubtless such hint as to their readiness for service is true, in view of the habit of the Imperial Government of dispatching officers and men in time to receive and man the ships contracted for on their completion in foreign countries; and, in my judgment, knowing Japan and her aims as well as I do, our Government will make a grave mistake if it does not give pronounced heed to what is in the air—Japan's wish to plant her flag at Hawaii.

There should be no occasion for the United States and Japan to clash in any direction, but our interests can never permit Japan or any other power to seize and hold that group of islands in the

North Pacific, destined to become the most important commercial center in that great ocean. It will be, indeed, the most stupendous blunder of modern times if we allow any other flag than our own to float in sovereignty over that gem-like possession, and the sooner our flag is planted there the better. It ought to be there now; that would settle the matter, and give the diplomatic world something else to think of. Japan's strong and earnest protest bids us beware of delay; immediate action is urgent. Were I the commander-in-chief of the Army and Navy of the United States, having before me the free and unreserved offer of the islands, and with a signed treaty in my hands, I would order the fastest steamer we have in Pacific waters to proceed to Honolulu with all dispatch, carrying orders to the minister and admiral to hoist the flag over the islands instantly. That would be a Jeffersonian or Jacksonian method, which, at heart, the American people like. It would also be a refreshing incident of administration akin to naval administration in time of war, and, quite likely, would save a vast deal of complication in future.

To turn back to the matter of our civil war, let me remark that if such tragic episode in our national life had, under the purposes of God, to come sooner or later for the settlement of the grave questions hanging upon its results, then it was well that it came at the time it did; a time when the present power and range of ordnance, the limits of armor, and the development of the automobile torpedo and swift torpedo boats were still in the womb of the future. The naval part of the long siege at Charleston could not have been maintained had the Confederates been possessed of the heavy long-range guns, the rapid firers, and the swift torpedo craft of this day.

During the progress of that siege, the ironclads, when not in action at the front, used to lie quietly well down the channel inside the bar. And further down towards Stono inlet were anchored, in positions regarded as safe from attack, the ordnance, the store vessels, and colliers. Such immunity from attack would be impossible now, in face of the newly-acquired power of the torpedo, for from personal experience, I think it safe to say that, on an average of one night in three, the waters of our southern coasts are so overborne with mists that torpedo craft of the advanced speed of to-day—25 to 30 knots—well handled, could have got in their work upon us, in rebellion days, inside Charleston bar, with fatal facility.

The demands upon the Navy in that four years' war were unique. Save the Sumter and Alabama, the Florida and Shenandoah, and a few lesser craft, the Navy had no enemy to look for on the ocean. The chief work was in fighting forts and earthworks; attacking the few ships that the insurgents had in bay, river, and harbor; establishing by capture bases of occupation along the coasts and on the Mississippi, for both the land and sea forces; co-operating with, and sometimes protecting, the army in its coast, river-side and Mississippi Valley operations; seizing and holding the great Father of Waters and its tributaries open to our movements and control, closing such strategic water communication to the use of the enemy; and the maintenance of that blockade which, for closeness, effectiveness, and pregnant results never had its equal in the world's history.

The work so outlined seems simple in statement, but it covers a vigor of administration, doggedness of purpose, splendor of valor, and brilliance of achievement never surpassed by other men of the sea, of whatever nation, in any age or period.

The conception and building of our fleets and flotillas on the Mississippi and its tributary streams is worthy of special remark; it never had its parallel in any other land, nor is it believed that any other people could have shown the aptitude, versatility, and ingenuity displayed by our people in the emergencies that called for their efforts in such unique way. It was a luminous illustration of our naval administration in time of war.

When the demand came, if my memory serves me right, the Department first sent John Rodgers, of glorious memory, to the West, to organize a naval establishment and begin the construction of suitable vessels for river service. He was given *carte blanche* to appoint officers and enlist men. When he had got construction and transportation well in hand, he was succeeded by the iron-hearted, indomitable Foote. He continued the work until compelled to retire because of a serious wound received in battle. Then followed Davis, cool, accomplished, and able. He fought and won the fleet fight at Memphis, and then yielded the command to David D. Porter, than whom as seaman, organizer, and fighter the chronicles of the ocean never knew his superior. To know what he did in those stirring days you must gather the story from the lips of his devoted officers and men, and read the memoirs of Grant and Sherman. He was our Sheridan of the sea—masterful, dashing, inspiring.

The things accomplished by the several commanders-in-chief in the lines of construction, transportation, and operation were wonderful. Steam vessels of the most nondescript character were converted, some into heavy ironclads, others to a lesser type of protected vessel known as the tinclad, while a multiplicity of smaller craft, of draft so light that they could almost float on morning dew, were fitted and equipped to penetrate the shallow creeks and inlets and show the flag in effective way to the rebel folk too retiring to be found in any other way. The salt-water sailor hitched his trousers alongside his fresh-water fellows, the pilot and steamboat man; and the comradeship of a common cause, instinct with fervid patriotism, unified their methods and traditions, and bound them together in a disciplined whole that made superb river crews and fighting material of the best sort. That was a creative and administrative feat in war from which lessons may be taken in future.

I submit the opinion that England, with all her glory of accomplishment, vast empire, and system of naval administration, could not have done so well on inland waters under like conditions; and we should bear well in mind what we did, and hand its record down to posterity, for the day may come when the flag may have to float over similar things and doings on the Amazon and the Orinoco.

In a war with a foreign power possessing a navy, entirely different conditions from those of our civil war will confront us, for which our naval administration should be prepared. It should not only be prepared, but, toward the end of thorough preparation, welcome suggestion from any intelligent quarter.

Bases of ordnance and coal supply, equipment material and fittings, engineer's stores, provisions, clothing, and appliances of every sort that the varied emergencies of war may call for, should be located and determined upon, at points the most remote and best sheltered from possible torpedo attack. I take it for granted that England's latest torpedo craft, of great speed, have sufficient seaworthiness to enable them to reach our coast from Bermuda with comparative ease. If such be the fact, they would prove to be ugly vessels to deal with, in the event of war with England. Our supply vessels, even under strong convoy, would have to be careful in their movements, to avoid being torpedoed.

The development and speed and the destructive powers of the

torpedo-boat would seem to indicate a new departure, if not another revolution, in naval warfare, which will have to be vigorously met. The huge battleship or the heavy cruiser, attacked by torpedo craft of 30 knots speed, in groups of five or more, would be apt to suffer like an animal attacked by a swarm of bees, especially under misty conditions of weather or at night. How readily the most watchful vessels can be approached by the low swift torpedo vessel at night, or during the drowsy hours just before dawn, only those who have had such experience can tell. The approach of the David that torpedoed the Ironsides off Morris Island and sank the Housatonic outside the bar, was discovered in good season, but not in time to prevent her getting in her nasty work, although her speed could not have been more than five knots.

Problem: You are lying in Gardiner's Bay, or in this harbor of Newport. It is 3 o'clock in the morning, a light mist hangs over the waters, but the search lights you display indicate your position to an alert enemy. All of a sudden the officer of the deck and the lookouts descry a torpedo-boat of 30 knots approaching at full speed. The alarm is at once sounded, but the men of the watch, already at the guns, though ostensibly awake, are in that drowsy state that makes one rub the eyes before thought can be sufficiently wakened to do quick, clear-headed work. Meanwhile the torpedo-boat is upon you. You may get in one shot, but the next moment the torpedo has done its work! This picture is not overdrawn; with the exception of speed, it is sketched from personal experience. But if several torpedo-boats attack you simultaneously under like conditions, your destruction is certain.

On this head I was somewhat amused at the report that came from Charleston one day last winter, when the simulated blockade had been established there by Admiral Bunce. The report said that after several days of exhausting blockade labors the admiral had suspended operations to give his people a little rest.

As my friend Bunce and I had served together on such duty at the same place, in time of war, year in and year out, without any relaxation whatever, it occurred to me that he must have smiled in reminiscent thought when he dictated the order in question.

But to return to the consideration of the torpedo boat, wise

administration would point to the building of one hundred or more of such craft, staunch and swift, and of model and tonnage to make them reliably seaworthy under the general conditions of our Atlantic-coast weather. Unlike Mr. Jefferson's gunboats, such vessels under their chosen conditions, which their great speed would allow, would match an enemy of much greater bulk, and equal him in other directions. One or more cable-laying and cable-destroying vessels should also be provided, for, in the event of a war with England, one of the most important things to do would be the destruction of the cable system that connects Bermuda and Jamaica with Downing Street. A British officer has said that "Bermuda holds a pistol at the head of New York and Boston." It behooves us then to be ready at the first stroke of war with England, to prevent the too ready use of that ready weapon.

The New York Herald does not take such view of submarine cables in any respect. It thinks the United States would do a sensible thing "if it took the initiative in proposing a congress for the consideration of the question looking to putting submarine cables under the protection of international law." The United States has done some foolish things. Admiral Porter used to say, indeed, that the Almighty took special care of drunken sailors and the United States of America; but if we consent to submarine cable immunity—an immunity that may at any time in war work towards our disaster, especially in a war with England, whose forts, dockyards, and arsenals, from Halifax all along our Atlantic and Gulf coasts, to the dominating naval stronghold at Esquimault on Vancouver island, at the entrance of the straits of San Juan de Fuca in the Pacific, constitute an ever-present menace to us—our foolishness will have reached its apex!

Yet can it have reached the apex when we consider that under the stress of our present relations with Spain, Japan, and England, Congress has adjourned, knowing that its enacted law as regards the price of armor, urgently needed for the battleships under construction, cannot be accepted by the firms engaged in such fabrication, except at a loss? What man, in truth, of ordinary intelligence, divorced from partisan considerations, can contemplate with simple candor and clear-eyed examination the present condition of our international relations, without coming

to the conclusion that war's stern encounter may be thrust upon us by one or more of the three powers named, within the next twelve months. Nor need it be said that the recent discoveries of gold in the Klondyke region of Alaska have not lessened the strain of our relations with England, as regards Canadian affairs.

In rebellion days, the major part of the telegraph lines being held by the insurgents, communication with the Department by our fleets was mainly maintained by water. In the event of war with a maritime enemy, our natural and ever-ready means of communication would be by land, provided the land and sea forces were able to keep open and protect such points of access; wherefore dispatch vessels for long-distance sea communication would not be imperative, as was the case during those memorable years of our civil war.

I do not know what provision this college has for the study of questions of strategic importance relating to harbors and anchorages and their relations toward operations in war, defensive and offensive, but certain it is, no officer can know the conditions of intelligent decision and successful movement from charts and books alone. Topographic features of coasts and harbors are as necessary to know as the hydrographic conditions of their waters, and it seems to me that for the best study of naval operations, a ship should be placed at the use of the president of this institution, to enable him to give the students, through practical examination, a thorough knowledge of the various points adapted for both defense and offense that an enemy would be likely to assail. A War College should have the means of forecasting war purposes and to formulate measures to meet and defeat such purposes of an enemy.

Where to draw the line between naval administration for war and for peace is a question, but it may be safely affirmed that such administration in war is the more concise, sensible, and effective; for, once the dogs of war are loosed, much discretion and independence of action must be conferred upon officers afloat in face of the enemy, or things will go awry and invite defeat. In the heat of war's fierce glow, red tape blanches white, then withers to ashes of disuse.

This recalls the story of the frigate Columbia at the Norfolk yard, away back in the forties. The ship had arrived from a foreign station to go out of commission. As she was hauling in to

her designated berth, the first lieutenant of the yard and the first lieutenant of the ship were at odds as to the manner of doing it. Said he of the yard, "Commodore Sloat wishes you to haul in on your stern line, sir"; but, broke in the "first luff" of the ship, "Commodore Blank wants a pull of the bow line, sir!" And so, until the ship got alongside the sea wall, the bandying went back and forth, much to the delight of the chuckling midshipmen, radiant over the fact that there were folks who dared "talk back" to the dogmatic, assertive "first luff" of those salty days.

One of the gravest problems confronting us to-day is the problem of manning our fleet in the event of war. We know that our deep-water merchant marine is gone, and under conditions that seem to make its rehabilitation almost beyond hope. We will be obliged, therefore, to turn to our coasting, river and lake craft for men to man our battleships and cruisers. Any plan or scheme to raise a force for service afloat, outside and beyond the control of the Navy in its character and scope, as one of the great arms of the national defense, under the direction of one head, will be, in my judgment, a grave mistake. At the outbreak of the rebellion, several bodies were raised for semi-naval operations. It soon became apparent, however, that such organizations should be merged in the Navy, if effective work was to be expected from the excellent personnel composing them.

In these days we know that bodies of naval militia have been organized by several of the seaboard and lakeboard States. Such movement has the active coöperation of the Navy Department, acting under the authority of Congress, and we may not doubt that in the event of war such organizations will do excellent service; but I submit the opinion that for harmonious and effective working, they should come into the Navy in the same manner as did the officers and men of our merchant marine in 1861. Wise administration would seem to dictate such policy, especially in the light of former experience.

During the war of 1812, the militia of some of the New England States refused to go outside of their respective state lines. It is to be hoped that like action will not be the outcome of the present movement to a quasi-naval reserve. Let us suppose that, in the pinch of war, an admiral's chief-of-staff were to say to the commanding officer of a Massachusetts force of naval militia, "The Admiral wishes you to proceed, sir, to Portsmouth,

N. H., and there await further orders," and were to receive this reply from the officer addressed, "But, sir, the Governor of Massachusetts wishes us to remain here!" It would be rather an awkward situation; but, unless my historic reading is at fault, something akin to such response and situation happened in one or more of the New England States in the war of 1812.

We already have two great organizations for national defense—the Army and the Navy. The two arms, in the nature of things, never worked so harmoniously together as to suggest still another, to add to clashing and complication.

An old petty officer of the service, in his occasional visits to me, speaks of the Massachusetts naval militia as "the swallow-tailed sailors from the Back Bay"; but that organization is made up of splendid material, and like the Eton boys at Waterloo, or our own lads who ran away from school and joined the ranks at Gettysburg, those web-footed militia will fight if but given the opportunity; but to get most efficiency—the best results in war time—their fighting efforts should be held under naval direction, utterly independent of State authority. At present the naval militia of Massachusetts is under the supervision of a soldier, the adjutant-general of the State. I cannot imagine anything more absurd. Wise administration in war will eliminate such an anomaly.

In January, 1896, Captain Eardley Wilmot, R. N., published a most original and interesting brochure under the heading of "The Next Naval War," illustrative of England's real unpreparedness for war, and the defects of the dual war office and admiralty control in the matter of coast defense. Let me quote a passage from it:

> It may be imagined what excitement prevailed throughout the country when it was known that war was actually declared. It was simply chaos. Has it not been stated of Moltke that on a similar occasion he was found reading a novel, and surprise being expressed at his being so engaged, he said: "The great work of preparation now ceases; we have to see the results of our labors." There was no such spirit at Pall Mall or at Whitehall. Many things that had been suggested as necessary, but put off, had to be taken up. One department besieged another with inquiries, demands, and requisitions. In addition, telegrams from the coast came pouring in. The military, having been intrusted with the safety of the harbors, had provided an elaborate system of defense by submarine mines, which necessitated the greatest precaution in going in or out. It had been wittily remarked there would be more risk in

time of war to our vessels entering their own harbors than approaching those of the enemy. This was now realized, for on an intimation from the War Office that the ports were to be placed in a state of defense, mines were laid in all the channels, and a dockyard tug coming into Portsmouth harbor, from a short cruise to warn friendly vessels of the condition of affairs, had first been diverted from her course by the persistent glare of a search light, and then ran against a loaded mine, which resulted in her being blown up, with all hands. This led to an angry discussion between the admiral and general. The latter said that, being responsible for the safety of the port, he must exercise his own discretion as to when and where mines were placed. Vessels should wait outside until they could be conducted in by a corps of pilots he was organizing. It was suggested that such delay might be of value to an enterprising enemy, and the admiral stated with emphasis that the dispatch of reinforcements to the fleet with promptitude depended upon his having full control of the immediate waters of the ports.

There was no alternative but to refer the matter to headquarters, and the attempt was made to define the responsibility of such service. This, on going into the matter thoroughly, was found to be hopeless. The First Lord plainly declared that unless the admiral was supported he must ask to be relieved of his office, and the Prime Minister seeing the urgency of the case, directed that the supreme control should be vested in the naval authority. This was nowhere received with greater satisfaction than at the ports, for in the meantime the generals in command had arrived at a sense of the anomalous position in which they had been placed. Soldiers had been allotted to complete the manning of the ports, but they had not the slightest idea of what constituted friends or foes. They could with difficulty be restrained from firing at everything that approached.

At the request of the officers in command, a naval party was sent to each port, who could pronounce upon the character of every craft that came near. It was found that forts, lights, and submarine mines could be worked efficiently as a single organization, but under dual control it must result in chaos and probably disaster. Barely two years before, the French Minister of War had pointed out in the chamber, and every other nation had adopted the policy we now found essential. But such a change can not be perfected in a few hours, and the enemy was not blind to the experience of the past, which has always found us unready in the early stages of a conflict. He knew that give us time and all these defects would disappear. Everything depended upon striking immediate blows. These were about to fall.

How graphically this description of lack of system, divided control, and perennial unreadiness depicts our own conditions and methods, as well as our ever woful lack of preparation to meet the ruthless demands of sudden hostilities! How admirably the gifted writer dissects and limns the follies and disastrous

plights of dual control of harbor waters in time of war, a control which with us would be the more difficult and complicated because of the closer touch of army men with the political forces of the country than navy men have, and the precedence given to that arm of the national defense; although in 1836, General Cass, as Secretary of War, said, in his annual report to the President, "That for defense of the coast, the chief reliance should be on the Navy; and that the system of 1816—that of the Board of Engineers—comprises works which are unnecessarily large for the purposes which they have to fulfill," to which opinion, the President, General Jackson, than whom this country has produced no abler soldier, gave his emphatic approval. But admitting as inevitable dual action and control of the Army and Navy, in harbor and coast-line defense in war time, under our conception of prerogative and systems of administration—civil, naval, and military—the advent of the naval militia as a third body of defense, under State control, would make "confusion worse confounded." I repeat, then, the opinion, that upon the outbreak of war, the officers and enlisted men of the naval militia should be temporarily absorbed by the Navy and made a part of the national force, as in rebellion days. Furthermore, I venture to say that sudden war would make the demand for men to man all our ships so urgent as to require the instant absorption of not only the naval militia into the regular service, but all the young men trained to seamanship on board the several State training-ships, and our yachting craft as well as our lake-board vessels. The stress of war cannot await the delays of theory; action pronounced, instant, and energetic can alone meet the emergencies of hostilities and the urgencies of administration incident thereto.

Fleet holiday showing as to efficiency for cruising and war is not to be relied upon, as I have said before. Let me further quote from Captain Eardley Wilmot's able paper on this head:

> The French had sent an ultimatum to England, which made the instant mobilization of England's fleet necessary. Seeing [says the gallant writer] what had been accomplished every summer for some years past, in mobilizing a large fleet for the annual manœuvres, and observing that with few exceptions and breakdowns we were able practically to double our squadron in home waters within forty-eight hours, it was hoped on this occasion there would be no difficulty in producing a like result. But it was soon seen that this was no criterion of our preparedness, *for on those occasions, with the date well known, this evolution had been*

*the special care of the dockyards for months previously. The manœuvres over, vessels that had participated in them were put aside, reports of officers in command as to urgent requirements were unheard, while all the energies were directed in pushing on new constructions, so as to show how rapidly a modern battleship could be produced.**

Though by dint of considerable pressure on the War Office, the ammunition for all vessels in the reserve had been provided, it was not kept in a convenient locality and had to be transported in lighters. A sufficient number of these, with due warning, could be hired, and it had been a novel sight in previous years to see a dozen ships simultaneously taking in this powder alongside the dockyard. But to send such an order without notice and at another time of the year was to find those responsible for this important part of naval equipment quite unprepared. Indeed, when the port admirals, on receipt of the order to mobilize, sent urgent demands for powder and projectiles, the ordnance store officers declared themselves unable to move until proper requisitions from headquarters had been received and arrangements could be made for transport. Then the anomalous condition, which places the most important and essential portion of a ship's fighting capacity under military control, was apparent. True, both services use powder and in theory a common store is economical, but why should not the navy supply boats, on the same reasoning, to soldiers and sailors? Anyhow, here was the first cause of delay, and the red-tape barrier was only overcome by the energetic action of our admiral, who at once sent an officer of his staff to assume command of the depot, while another was dispatched to hire all the lighters in the port. He remembered the procedure of Sir Edmund Lyons, when he had to make arrangements for landing in the Crimea, and the shock caused in the official mind by his prompt dealings at Constantinople with owners of necessary stores. But a little irregularity on these occasions wonderfully facilitates the movement of an army or fleet. It was found so now, for in a few hours twenty lighters had been found, loaded, and dispatched to the vessels fitting out.

Then a new difficulty arose. Orders had been received to fill up the crews of the coast-guard ships and commission every vessel in the reserve. There was now found a considerable dearth of men. The coast guard, a most efficient force, of about four thousand men, could only be drawn upon to a small extent, because to them was intrusted the important duty of working the signal stations which we had established all around the coast of the United Kingdom. This was an invaluable piece of organization, because it enabled the appearance of any vessel to be flashed to all parts. The efficiency of it, however, depended upon the men at those places being able not only to distinguish between a merchant ship and a man-of-war, and to detect the latter if disguised, but to know by appearance the nationality of an approaching cruiser. The experience of the coast-guard men made them adepts at recognizing their own vessels, and being furnished with photographs of foreign war vessels they could identify any hostile cruiser. Clearly their places could not be taken by

* Italics are mine.

landsmen, as had been proposed, or even seafaring people without experience. Hence the coast guard could not be sent afloat in any numbers.

The naval reserve was called out, but no one knew where the men were coming from, or in what numbers. As they mostly belonged to the principal steamers, the owners regarded with dismay their vessels depleted of men. The slow steamers and sailing ships, which were likely to lay up in war, carried few, if any, reserve men. It was seen that we had been trusting to a broken reed in our system for manning a large fleet at prompt notice. A week had elapsed before even five thousand of these men had reached the ports, and few having served in a man-of-war, they had not only to be instructed in the most elementary routine duties, but it was a week before they could find their way about the ships to which they were sent.

These pictures of maladministration, so ably drawn by our distinguished kinsman of the sea, are in no whit overdone. In the blunderings he depicts, with so searching an eye, so fearless a pen, we feel that more than ever we are "chips of the old block." It is, we may not doubt, a peculiarity of the Anglo-Saxon race, that up to a certain point of preparation for war he is unequaled. In marine affairs, affairs that concern him most of all, he recognizes the necessity of having ships and guns—powder and projectiles of latest type—power and efficiency for both defensive and offensive purposes, but when it comes to the most vital part of the whole organization as to personnel, which will provide equally in war or peace crews for the otherwise ready ships and fleets, he is sadly at fault.

The drawbacks of the British system, so plainly disclosed, we cannot think are overdrawn; the remedy for the shortcomings outlined is difficult to apply, owing to the temperament of the British race and its abhorrence of coercion in any form. The days of the pressgang with its brutal methods are no more. The men of the British merchant marine—of whom to-day not less than thirty per cent are foreigners—will not enter the Royal Navy. The memories of the old-time discipline of that service, rigid and unrelenting, ofttimes unfeeling in its incidents and cruel in its punishments—linger in the British mind and deter men from entering that arm of the Queen's service. The marine conscription that the continental powers enforce with such vigor no British ministry would venture to try in the British Isles. Yet there has been a wonderful amelioration in the condition and treatment of the British man-of-war's man during the past

forty years. Privileges that in Nelson's time would have been looked upon as preposterous and dangerous to authority are now freely granted. The question of manning her fleet has ever been the more serious to England, because of the vital necessity of the readiness and efficiency of that fleet to her very existence as a power. Wherefore, in these later years of naval demand the British Admiralty has adopted the plan of long enlistments, an extended and effective system of training ships and schools for boys, a carefully-devised scheme of pensions for long-service men, and a well-considered grant of privileges to their seamen, astonishingly democratic in character. The British man-of-war's man feels to-day that he is the most important factor in the Empire, and what he once ventured to ask for with fear and trembling, he now boldly demands.

In the wise spirit of conciliation and justice with which he has been met, he is made to feel that his interests lie in the service, that he is a man to be considered, and he concludes to remain in a service that accords so much to him, as an indispensable factor of the national life.

Have our seamen met with such judicious treatment? Let us give a case in point. In the height of our civil war the time-honored grog ration was suddenly abolished in our Navy. Not a single seaman was consulted as to his wishes in the matter nor as to its expediency. Old salts who had served in the war of 1812 and the Mexican war were abruptly told one day that there was no more grog for them, and it hit them hard; so hard, indeed, that many of them left the service for good after the war. The British Parliament would never have ventured upon such an invasion of centuries-old sea ration and custom, without taking the sense of those most closely affected.

But despite England's administrative efforts toward the maintenance of an efficient and unfailing personnel for her navy, it is undoubtedly a work of great difficulty, for disablement, desertion, and death, and the requirements of foreign stations strain her seafaring resources continually and to the utmost. And when it is claimed that the ships comprising the recent jubilee display at Spithead were in all respects ready for war service, I repeat that we may well doubt it. Probably not half the vessels of that holiday occasion were really ready for battle or cruising purposes. The conditions of the mythic fleet so vividly

portrayed by Captain Wilmot would doubtless have found some counterpart at that great marshaling of England's fleet—echoes of whose real unpreparedness will doubtless from time to time break upon the world's ear, as the memory of that spectacular demonstration fades into the past.

A word more and I have done with Captain Wilmot's remarkable paper, although its entire presentation of the situations and happenings it deals with in imagined naval chronicles ought to be carefully read and heedingly considered. That word is to suggest the fact that whatever have been the shortcomings of our own naval administration, whether in peace or war, we have not been at all dependent upon the army establishment for our ordnance or any detail of supply or equipment pertaining to it, since the war of 1812 and perhaps prior to that period. Our advantage over the British Navy in that respect is marked and distinctive. No Woolwich gun factory or arsenal under army control has stood in our way or balked naval endeavor. Our naval ordnance was superior to that of the British naval service in 1812 and has continued so ever since—barring the interregnum after the civil war when we rested on our oars and looked on while other nations did the experimenting, until the problem of safe and effective rifled cannon of high power had been satisfactorily solved. Then we know that our Bureau of Ordnance, which had kept itself thoroughly informed on every incident of progress and factor of success abroad, set about in earnest under the able lead of Captain (now Rear-Admiral) Sicard—the chief of bureau—and his assistants to build guns for our Navy. This was the more readily accomplished because of the progressiveness and thorough business methods of Secretary Whitney, in his brilliant administration of the Navy Department during Mr. Cleveland's first term. The naval gun factory established at the Washington yard stands as a lasting monument to his enlightened grasp of naval needs and of his administrative genius on new lines of effort.

The guns built at that establishment, whether of small or large caliber, have not been surpassed in strength or safety, power, and endurance, so far as I have been able to learn, by any guns made by the most celebrated gun makers of Europe. In truth, if my memory serves me correctly, guns have burst in use on various occasions on board the ships of England,

France, Germany, and Russia, but no accident of such gravity has yet happened to our ordnance, planned in every detail by our officers and built under their direction.

In the early forties the frigate Cumberland bore the broad pennant of Commodore Joseph Smith as commander-in-chief of the Mediterranean. Captain Samuel L. Breese was her commanding officer, and Lieutenants Andrew H. Foote and John A. Dahlgren were first lieutenant and flag lieutenant, respectively. They were all regarded as officers of great merit—a reputation more than confirmed by their subsequent services, both in peace and war. They were also warm personal friends and ever hung together. It was during that cruise in the Cumberland that Dahlgreen told Foote he had become so much interested in ordnance that he was going to make it his service specialty. The result was, as you all know—after much obstruction on the part of his seniors, but persistent effort and stout battling on his own part—the Dahlgren system of ordnance, which, up to the advent of the safe high-powered rifled gun—which took many years and enormous expenditure of money to accomplish—was undoubtedly the best gun in the world, especially for naval purposes.

The last time I saw the admiral was in March, 1865, when, Charleston having fallen, I was detached from his command and ordered to join Admiral Godon's special squadron to Havana, in quest of the rebel ironclad Stonewall. When I called to bid him good-bye, he seemed to be much disturbed at a letter he had received from the Bureau of Ordnance, asking his consent to have his 9-inch and 11-inch guns cast in future on the Rodman principle. He talked more than an hour in the most fascinating way upon the subject of naval ordnance. Among other things, he said, "Several thousand of my guns have been in constant use during the war, and not one of them has burst or shown the least sign of weakness. Nor have I ever received a cent of royalty from the Government." "Now," he bitterly continued, "they want to change the character of their construction, but they shall not do it with my consent." He was certainly justified in his anger.

He was unquestionably the ablest and most accomplished officer in ordnance of his time, whether in our own service or in any other. To his genius and labors, let me repeat, the country was indebted for the best and most effective smooth-bore

guns the world ever saw. The perfected rifled gun of this day has alone rendered them obsolete. It is said that his last days, like those of Dupont, were embittered by belittling procedures at Washington, which left their sting of injustice and brand of discourtesy to rankle in his breast and hasten his end.

Some time after Admiral Dahlgren's death, his widow asked Congress to vote her a sum of money, as a recompense for her deceased husband's eminent work in ordnance, especially for the heavy guns he had devised. While the bill was under discussion in the Senate, General Logan, who, with his army experience, ought to have known better, arose in his place and said, "There must be some mistake in this matter, for navy men do not know how to make guns. Our heavy guns are all made by army men, on the Rodman plan." This dictum is mentioned to illustrate general ignorance as to what the Navy does and has done. The only Rodman guns ever used in the Navy were the 15-inch guns of the monitors. Dahlgren opposed their being cast on the Rodman plan, but was overruled by Secretary Welles and the Bureau. Inasmuch as no gun cast on the Dahlgren system ever burst in action, while one of the 15-inch guns of the Mahopac blew off its muzzle after a few rounds at Fort Fisher, and several of them cracked inside at the bottom of the bore, in the region of the vent, Rodman and his friends are quite welcome to the glories of the 15-inch gun cast on the General's process.

In a little service talk I had with General Abbot of the Ordnance Corps—now retired—at Atlanta some two years ago, he was loth to acknowledge that the Navy was the first to make the built-up rifled guns in this country. I insisted that the Navy not only established the first plant for the building of such ordnance, but had turned out several guns before the Army moved in the matter at all. If my statement was too positive, I will be glad to be corrected.

It was perhaps a happy circumstance that our captains during the civil war were unhampered by constant touch with Washington, otherwise the victories won at Hatteras Inlet, Hilton Head, Forts Jackson and St. Philip, and Mobile Bay, might have known no place in our annals. But let us give due acclaim to our naval administration in war which gave so much discretion to our flag officers, allowed them to promote volunteer officers for gallant services on the spot, supplied them most lav-

ishly with means for effective work against the enemy, and kept the service a regular organization from first to last. With us of the Navy there were no State organizations. There was no Fifth New Hampshire, Sixth Massachusetts, Tenth New York Regiment and the like to deal with, as was the case with the Army, as to its domination, but it was ever, as before and always, the Navy of the United States.

When officers were appointed from the merchant marine, they were received with honor and given due position, but never highest commands. Moreover, when it was suggested in some quarters that Assistant Secretary Fox, Captain R. B. Forbes, of Boston, and one or two other distinguished men of sea training should be made rear-admirals, the old-time battle-seasoned officers of the service had the courage and influence to stop it.

In conclusion, I pray you study the naval history of your own country, its naval administration, and the lustrous achievements of your brothers-in-arms who have gone before; achievements, not so varied in character, nor so extended in scope, indeed, as the stirring deeds of the great British seamen which Mahan has so vividly portrayed, but every whit as brilliant in conception, daring in execution, and momentous in results.

The English have been wont to say that Napoleon never encountered a first-rate general until he met Wellington, but in all his fighting Lord Nelson never had to contend with a first-rate man of the sea. His victories were all won over second-rate, half-hearted captains, as at the Nile and Trafalgar, or men taken by surprise, as at Copenhagen—that most notable naval instance of national assassination of modern times.

What a difference he would have found, we may think, in battle tests with a Farragut or Porter, a Foote or a Rowan! Had it been his fortune, in truth to meet in battle seamen of such intrepid sort and unfailing resource, I venture to say that his epitaph would have been differently worded!

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

INTERNATIONAL LAW. NAVAL CAPTURES.*

By General Francis J. Lippitt.

Mr. President and Gentlemen:

My lecture is nothing but a long series of propositions of dry law, and, of course, must be more or less tiresome to any other audience than one of professional lawyers. I am therefore somewhat reluctant to read it to you, but I shall venture to do so, hoping that your interest in the subject is such that you will not find it to be *too much* of a bore after all.

As a full discussion of the subject of naval captures would be impossible in a single lecture, I shall limit myself to stating the principles governing in such cases as most often occur.

In time of peace no capture can be lawfully made except in the case of piracy. But where a vessel, whether a domestic or a foreign one, has been violating the laws of a country, the nation's cruisers may lawfully pursue, stop, and bring her in. In the case of a foreign vessel, the chase, it is said, should have commenced within the three-mile limit, or else the vessel must have just escaped from it, as in the case of the Chilian ship Itata, supposed to have been violating our neutrality laws. But in this instance the seizure is made, not *jure belli*, but in the cruiser's performance of national police duty, and is not a capture in the proper sense of the word.

In the case of piracy—now extremely rare, except in certain Asiatic waters—the captured vessel must be brought in for adjudication by an admiralty court, and her condemnation entitles the captors to prize money.

* Lecture delivered at the U. S. Naval War College, July 23, 1897.

In respect to these two cases of seizure, the right of visit and search would be necessarily implied. The exercise of this right requires the utmost caution; since, if a mistake has been made, the commander would be legally liable in damages. But if the visit and detention was fully justified by the circumstances, it would not constitute a serious cause of complaint against the cruiser's nation; and though the commander might be mulcted in damages, he could justly claim to be indemnified by his government.

As to piracy: it is important to bear in mind what piracy really is under international law, which characterizes pirates as *hostes humani generis*, enemies of mankind, robbers on the high seas. And the question always is whether the intention of the supposed pirates is to capture and destroy *jure belli*—by right of war—the property of a particular nation or government with which they are fighting, or, on the other hand, to depredate criminally on the ships of all nations for private gain—*animo lucrandi*—which alone is piracy under international law.

Piracy, made so by a nation's municipal law, is a totally different thing, as for instance, our act of 1790, declaring robbery on the high seas of an American vessel by our own citizens to be piracy, and making it punishable as such. So, while the slave trade lasted, by treaties between certain nations it was characterized as piracy, and their respective war ships were empowered to visit, search, and capture each other's private vessels that were engaged in it. That trade being now abolished, those treaties have become obsolete.

It follows that, although insurgents may be treated by their own government as rebels and pirates, they are by no means pirates under international law. Apart from the enforcement of a nation's neutrality laws, it has no right to assist in the suppression of an insurrection which concerns only the insurgents' own government. In fact, the motives of insurgents are often patriotic, and other nations have no right to judge whether an insurrection is justifiable or not. And so long as the insurgents' government insists that no war exists, it has not the belligerent right of capturing them on the high seas.

In 1873 the British ship Deerhound was captured by a Spanish cruiser on the high seas, with arms and munitions of war for the insurgents under Don Carlos. Great Britain claimed that as

there was no war declared, there existed no belligerent rights; and Spain had to restore the ship and release the passengers, including Don Carlos himself.

In the same year the steamer Virginius, carrying the American flag, was captured by a Spanish cruiser on the high seas—no war admitted by Spain to be existing—and carried into Santiago de Cuba, where the captain and fifty-two of the passengers were summarily tried and shot. The United States demanded of Spain: (1) Restitution of the ship; (2) release of the survivors; (3) signal punishment of the officials; (4) ample indemnity for the families of the American citizens executed; (5) a salute to the United States flag. All these terms were submitted to, but on its being ascertained that the United States flag had been fraudulently used, the salute to the flag was waived.

It is plain that a denial by the insurgents' government of the existence of war, while it is actually being carried on by organized forces in the field, cannot be allowed to prejudice the rights of other nations or of their citizens. Consequently, foreigners captured fighting in the ranks of the insurgents cannot be treated under international law otherwise than as prisoners of war, and their trial and execution by court-martial as rebels would be a lawful cause of war to their own nation. "Oh, but filibusters! filibusters!" some may exclaim: "They surely have no rights that a law-abiding people are bound to respect!"

This reminds me of the good old Quaker who, being one day very angry with his dog, said to him, "Friend, I will not hurt thee, but I can give thee a bad name!" With that he opened his front door and pushed the dog out, shouting "Mad dog!"

It is often asked, "What's in a name?" But sometimes there is very much in a name.

I would remark here, before passing to our main subject, that in no case whatever in time of peace can a war ship of one nation be subjected to the jurisdiction of any foreign one, and an attempt to do this would be a violation of her nation's sovereignty.

In 1879 the United States ship Constitution went aground on the coast of England. Assistance was rendered by a tug. A dispute arose as to the amount of salvage to be paid, and a warrant was applied for for the frigate's arrest; but it was refused by the government on the ground that, being a foreign war vessel,

she could not be made amenable to the jurisdiction of the country.

We now come to our main topic, Naval Captures in War.

War is always a terrible evil. Nevertheless it is sometimes unavoidable, as when there is no other means possible of vindicating the rights of the nation or of its citizens. Obviously the interests of both belligerents as well as humanity require that it should terminate as soon as possible. Thus each belligerent is justified in using the most efficacious means of inducing his adversary to make peace, and this is by inflicting on him as much loss as possible. In a maritime war this means the capture of his war ships and the property of his citizens floating on the seas, thereby ruining his commerce. Though, in a maritime war, the practice of nations does not sanction the capture of property on land, it allows the capture of all his property, public or private, afloat on the high seas or in his own waters. It moreover recognizes the right to blockade his ports and to levy a contribution on them, on pain of bombardment should it be refused.

Naturally the first question is, In what cases is capture of property lawful under international law?

For the sake of clearness, I shall consider: (1) Where a capture may be lawfully made, (2) the case of property belonging to the enemy, (3) the case of property belonging to the belligerent's own citizens, (4) the case of property belonging to a neutral.

1. A belligerent cannot lawfully act hostilely except on his own territory, on his own ships, or on the enemy's ships or soil. A capture, therefore, in the waters of a neutral is unlawful, being a violation of the nation's sovereignty. Nevertheless in a prize court such a capture, as between the two parties, is deemed valid. The nation aggrieved, however, has a clear right to demand indemnity of the neutral government, whose duty it was to keep the peace in its own waters.

In 1814, during our war with England, the American ship General Armstrong was attacked and destroyed, after a heroic resistance, by British war ships at Fayal in the Azores. Our Government demanded indemnity of Portugal. After many years it was agreed to submit the question to the French president as referee. In 1851, the referee decided that there can be no claim where the ship resisted, instead of demanding protection from the authorities. But must the ship wait till this formality is complied

with, due deliberation had on the demand, and the demand either acceded to or refused, before firing a shot in self-defense?

2. Next, as to the case of property belonging to the enemy.

Enemy's property has always been liable to capture, even on a neutral ship; though, in that case, the master was usually entitled to his freight, it being a lien on the cargo. But this right was in some instances expressly waived by treaties between certain nations. Finally, by the Declaration of Paris of 1856, to which all nations were parties, except the United States, Spain, and Mexico, enemy's goods on board a neutral vessel are no longer liable to capture. The rule is briefly expressed by the term Free Ships, Free Goods. Of course this exemption would not hold where a fraudulent use is made of a neutral flag.

To this declaration the United States declined to be a party, unless *all* private property on the seas should be exempt from capture, whether belonging to the enemy or to a neutral. The ground of our objection was that in war it is necessary to destroy, as far as possible, the enemy's commerce, this being the most effectual means of inducing him to make peace; that the United States, having a small navy, which could not cope with that of a great naval power, could not afford to relinquish, even in part, her power of destroying the enemy's commerce, unless her own commerce should be protected by exempting *all* private property from capture.

But consider. Were all private property afloat exempt from capture, a naval war would consist only of combats between battleships, and the nation having the most formidable navy would be sure to win in the end; just as in military operations on shore, victory perches on the banners of him who has the heaviest battalions. The result would be that a weak naval power, in a contest with a powerful one, had better make peace as soon as possible.

Another rule established by the Declaration of Paris is the abolition of privateering.

To this article also the United States objected, on the ground that war is simply a trial to ascertain which nation can do the other the most harm, not from any vindictive motive—God forbid!—but as the only means of inducing the enemy to make peace. The importance of privateers in this respect is illustrated by an article in the Edinburgh Review in 1814, showing that in two

years the United States had captured, chiefly by privateers, over seventeen hundred British vessels with their cargoes. How much this fact may have contributed to the making of the treaty of peace in December of the same year we shall probably never know. Now, unless *all* private property should be exempt from capture, in a war with a great naval power, one-half of whose navy might suffice in a great measure to compel our own small navy to confine itself to defending our own coasts, the other half might be sweeping our commerce from the seas. Thus no other course would be left us but to employ the thousands of our merchant vessels and the thousands of our sailors thrown out of employment by the war, as privateers to be sent against the enemy's commerce. Abuses, no doubt, often occur in privateering, but they occur also in all volunteer armies, especially before, after much campaigning, they have become thoroughly disciplined.

What would be the result, in case of a war, of our refusal to become a party to the Declaration of Paris, it is not easy to predict.

In order to prevent any evasion of the belligerent's right to capture enemy's property, no change in the ownership of a vessel or of its cargo made *in transitu*, during her voyage, is recognized as valid, and the question always is, in whom was the property vested at the commencement of the voyage? If the cargo was shipped deliverable to a consignee in the enemy's country, the consignee is deemed to be the owner, and a delivery to the master is deemed a delivery to him; and it would consequently be held capturable. And so, under British decisions, as to goods shipped to a consignee, even in contemplation of war. But whoever was the owner at the beginning of the voyage, it is sufficient if the property belonged to the enemy when captured.

It has, however, been held that a transfer *in transitu* would be treated as lawful when conclusively shown to have been made in good faith.

3. Let us now consider the case of property belonging to the belligerent's own citizens.

Such a thing as a partial war is unknown to international law, which deems all the citizens or subjects of the respective belligerents, as well as their nations, as enemies to each other, and forbids not only all trading, but also all intercourse between them.

Since, the moment war has commenced, all trading or inter-

course with the enemy becomes unlawful, the offender's property would be capturable by cruisers of his own nation. A British subject's vessel, after war had commenced, was proceeding to the enemy's country merely to bring home his property there situated. She was captured by a British cruiser and confiscated by the British prize court, though no trading had been intended, the court holding that mere intercourse with the enemy is unlawful.

On this ground, were we a belligerent, one of our own vessels caught sailing under the enemy's convoy would be liable to capture by our own cruisers, and to confiscation of both ship and cargo.

Sometimes it is for the interest of a belligerent government to grant a license to its citizens to trade with the enemy. In such case the license covers only the articles specifically mentioned, and if it be abused, the licensed vessel is capturable by the belligerent's own cruisers. Moreover, the license does not protect from the consequences of a breach of blockade, or of carrying contraband of war, or against visit and search.

Again: All persons domiciled in our enemy's country, even our own citizens, must be treated as enemies, and their property is capturable as such. The status of belligerents as between themselves would admit of no other rule. Any other line of discrimination in the midst of hostile operations would be plainly impracticable. But should one of our own citizens domiciled in the enemy's country be a partner in a house at home, it would be only his share in the partnership property that would be confiscable. It follows, on the other hand, that the property of a subject or citizen of the enemy's country domiciled in ours is exempt from capture by our cruisers; but not so by the cruisers of his own nation.

4. We now come to the case of property belonging to neutrals.

There are three cases in which neutral property may be lawfully captured, which we will consider under their respective heads:

Contraband of war;

Breach of blockade;

Such a use and employment of the neutral's vessels as to aid the enemy in carrying on the war.

(*a*) And first, as to contraband of war. The right of a neutral to trade with any and all other nations, both in peace and in war, is unquestionable, but a belligerent has a right equally unquestionable to capture all neutral property destined for the enemy that would aid him in his hostile operations. Here, then, is a direct conflict between two equal rights. Obviously, one of these must give way to the other, but if the belligerent's right should yield to that of the neutral, the warlike supplies furnished by the neutral to the enemy would be ruinous to the success of the belligerent's hostile operations, enabling his enemy to prolong the war indefinitely. International law adjudges the belligerent's right to be the superior one. Now, this superior right can be enforced in no other way than by the capture and confiscation of the neutral's property whenever its nature and destination are such as to assist the enemy in carrying on the war.

The broadest definition of contraband of war that can be given is: All supplies that are peculiarly adapted under the circumstances to aid the enemy in his hostile operations, the term "supplies" being understood to cover also all military persons and dispatches. To enumerate the great variety of articles that have been held in certain circumstances to come under this head would consume too much of our time. I shall therefore confine myself to giving a few illustrations under the general principle; a full summary on the subject will be found in Snow's International Law, as edited by Commander Stockton, U. S. N., in section 61.

Always capturable as contraband articles are all such as would be of *direct* use in naval or military operations, as arms, munitions of war, and naval and military supplies of all kinds. As to articles of ordinary consumption in time of peace, such as food supplies, ordinary clothing, ship canvas and cordage, coal: under certain circumstances these might be as important to the enemy in carrying on the war as warlike munitions. Such articles, though innocent in themselves, would sometimes be held capturable as contraband, if destined to a port of naval or military equipment, but in other cases they would usually be held exempt from capture; and if appropriated nevertheless by the captors, they would be bound to allow a fair price to the neutral owner, and the freight already earned by the vessel. These articles, capable of use both in peace and in war, and such others as masts, ship timber, machinery, horses, money, are ordinarily innocent; and

so as to food supplies; but meat put up in cans, sea biscuit, and other provisions in a form especially adapted for naval or military use, would certainly be capturable if destined to a port of equipment, naval or military.

Manifestly, the law as to contraband must always remain in a fluctuating and unsettled condition. It is the interest of the neutral on the one hand to contract the list of the contraband, and of the belligerent on the other to extend it; and the decision as to contraband, or not contraband, belongs to the prize court having jurisdiction of the capture. When the articles in question are of the peculiar growth or manufacture of the neutral's own country, and carried in his own ships, more favor is shown to them in prize courts than in other cases; perhaps in view of the very just rule, that, so far as possible, the industries of a neutral nation should not be stopped by a war in which it has no concern.

In view of the uncertainty as to what might be adjudged contraband, maritime nations often stipulate by treaty what articles shall be deemed such in case of a future war between them.

In the capture of contraband, all other goods on board, though innocent, and even the ship itself, if belonging to the same owner, are confiscated. The ship also is confiscable when her owner knowingly allowed the carrying of the contraband, and the penalty attaches the moment the vessel has set sail on her voyage with the contraband on board. But she cannot be captured on her return voyage after successfully landing her contraband. She and the belligerent cruiser have been playing a game of skill, and the neutral vessel has won, and her subsequent capture would be an act of sheer vindictiveness, which international law does not sanction.

It is settled that the penalty for carrying dispatches to the enemy would not be applied to a mail steamer, which is under obligation to receive and deliver all mail matter delivered to it, with no opportunity to examine its contents. Whether this exemption would be recognized in a case where the owners of a mail steamer were actually aware of the contents of the dispatches, is a question that has not yet come up for adjudication.

In order to avoid capture, the neutral vessel carrying contraband is sometimes cleared for a neutral port; and, the better to deceive the belligerent as to her real destination, the cargo is sometimes landed there and afterwards reshipped. But if it ap-

pears that her ultimate destination was to an enemy's port, the voyage is deemed a continuous one, and confiscation follows of course. And so even when the cargo is not only landed but the duties are paid. Nothing short of the goods having been actually imported into the general stock of the country would prevent confiscation.

(*b*) We come now to the subject of blockade.

The object of a blockade is to prevent the introduction of any supplies to the enemy, and to suspend all trading or intercourse with the blockaded port. To accomplish this, all neutral vessels, whether entering or leaving the port, are capturable, with their cargoes. To constitute a valid blockade there are three requisites:

(1) It must be imposed by competent authority, either by the belligerent's government or by a naval commander possessing a general authority to that effect.

(2) It must exist in fact. No mere paper blockade is now recognized by international law.

(3) It must be so conducted as to make it dangerous for the neutral to enter or pass out, and a mere attempt to do so would authorize confiscation of both ship and cargo. Even hovering about, watching for a chance to enter or leave, is held to be equivalent to an actual breach of the blockade.

If the blockading ships are driven away by a superior force, the blockade is thereby ended; and if afterward it be recommenced the neutral must be notified *de novo*. But not so if driven off by mere stress of weather; in which case the neutral may lawfully avail himself of the opportunity for entrance or egress. And when a ship is compelled to enter by a distress that is palpable, immediate, and pressing, the penalty is not incurred.

Whenever there was knowledge of the blockade at the neutral's port, the mere sailing for the blockaded port makes the ship and cargo liable to capture at any time during the voyage; and ignorance of it is never presumed, though it may be established by evidence.

Formerly, when the neutral country was at a great distance from the scene of hostilities, as in the case of the United States and ports in Europe, prize courts usually presumed ignorance of the blockade for a certain period; but this presumption is now obsolete, since the institution of a blockade is now instantly known everywhere through the telegraph.

In justice to neutral ships lying in the port when the blockade commenced, a notice is given, usually of fifteen days, before their egress is prohibited. In such case, inasmuch as the belligerent's right did not vest until the blockade actually commenced, the ship may leave with all of the cargo taken on board before that time; but if any of the cargo was taken on board after the blockade commenced, she is liable to capture and confiscation.

After a breach the ship and her cargo remain capturable until the end of the voyage. The reason of this is plain. Her breach of blockade has forfeited ship and cargo and made herself liable to be pursued and captured. And if afterwards caught by the belligerent, whether at only 5 or 10 miles, or at 500 miles from the port—the voyage still continuing—it makes no difference in principle; but if the blockade has been raised in the meantime, she is no longer capturable.

As belligerents are bound to treat all neutrals alike, if one neutral vessel is allowed to enter, this nullifies the blockade as to all.

As to neutral mail steamers: They are allowed to enter if carrying no contraband, but they cannot engage in any trading in the port, and are bound to comply with all reasonable restrictions imposed by the belligerent during their stay there.

Under international law and usage there may be enforced a blockade in certain cases, even in time of peace, a breach of which by the neutral must be attended with the same penalties as in time of war. Obviously, a "pacific blockade" not binding on neutrals would be a mere farce—a nullity. But it has been held that in such a blockade the captured vessels should not be confiscated, but simply sequestered until the blockade should be terminated.

(*c*) We now come to cases where neutral vessels are liable to capture in consequence of certain relations with the enemy.

A neutral vessel, when used or employed in aid of the enemy's hostile operations, whether voluntarily or involuntarily—involuntarily, because otherwise the rule would be easily evaded—is liable to capture and condemnation. And so when sailing under the enemy's license, thus protecting from capture his own vessels, which would otherwise be employed in the enemy's trade.

It has long been the policy of maritime nations to exclude other nations in time of peace from their coasting and colonial trade, but in time of war a belligerent's vessels engaged in such

trade would be liable to capture by the other belligerent. It would be, therefore, of great advantage to him to permit this trading to be carried on by neutrals; but neutral vessels availing themselves of this privilege would obviously be rendering assistance to the belligerent nation, and therefore be liable to capture. The rule is that a neutral, in time of war, cannot lawfully carry on any trade with a belligerent not open to him in time of peace; but in more recent times the enforcement of this rule appears to be very much relaxed.

It would seem that, under general usage, a belligerent has no right to visit or capture a neutral vessel convoyed by a war ship of her own nation, but early in the present century a British prize court condemned a large fleet of Swedish merchant vessels, convoyed by a war ship of their own nation, Sweden being then a neutral and friendly power. The pretext was an alleged attempt to resist a visit and search of one of the vessels, but virtually, in my opinion, there was no actual resistance made, the convoying ship being obliged to submit to superior force.

It is now generally agreed that, whether resistance to visit and search by the convoying neutral ship would or would not justify capture and confiscation, the commander of the convoy should be required to give his personal assurance as to nationality and of their being no contraband on board, for the belligerent has a clear right to be satisfied on these points. Between certain nations there exists a positive agreement that the commander's declaration as to nationality and the non-existence of contraband on board shall be accepted. As for the United States, our regulations for the Navy of 1876 forbid the commander of a convoying ship to allow a vessel sailing under his convoy to be searched or detained, but require him to be satisfied as to its nationality and the non-existence of contraband going to an enemy's port.

This leads us to consider the subject of Visit and Search.

A belligerent has certainly a right to know whether a ship is enemy's property; or, if neutral, whether she is carrying contraband to the enemy, and to ascertain her real destination. This right can be enforced in no other way than by a visit and search. And this right is necessarily implied in the right to capture, for without it the right to capture would be obviously futile; and the exercise of it, if properly conducted—that is, if the boarding officer behave with proper courtesy, doing no injury, and with-

drawing immediately after the search—no neutral nation would deem it a serious cause for reclamation. Of course the right can be exercised only on the high seas, and never in the waters of a neutral state.

A resistance to search justifies capture and forfeits both ship and cargo, but not where the existence of war was unknown. In such case resistance would be justifiable, since the right of search does not exist in time of peace. A mere attempt at flight before possession is actually taken is no ground for condemnation.

The boarding officer should be accompanied by two or three men only, with a view to prevent any inclination to insulting or overbearing conduct. For any injury to the vessel or cargo, or for any oppressive conduct should the vessel be brought into a prize court, it would inflict compensation out of the fund in court, and no unnecessary detention would be lawful, and no act beyond the scope of the object in view is permissible; but the search may be thorough, including an examination of the ship's papers and log-book, of the cargo, the equipment, the crew, and the nationality of the passengers. Any of these particulars might throw light on the nationality and the destination of the vessel and as to the existence of contraband. Concealment or spoliation of material papers would be ground for condemnation, unless satisfactorily explained. The use of *false* papers, made to deceive, would always be ground for capture and confiscation.

A belligerent ship sometimes requires the vessel to send her papers on board the cruiser for examination; but this should not be. It is surely enough if the neutral vessel passively submits to be stopped and searched, without being forced to take any active part in her detention.

Under our regulations, the belligerent ship may use the enemy's flag; but before a gun is fired, either as a signal or in making a capture, it must be hauled down and the national flag displayed.

The flag is *prima facie* evidence of nationality; but in time of war a neutral vessel would not be condemned for carrying the enemy's flag as a prudential means of avoiding capture by him, nor for clearing for an enemy's port in order to escape molestation.

In 1861, during our war with the Confederate States, the British mail steamer Trent, commanded by a naval officer, was sailing

from Havana to an English port. At Havana came on board as passengers Messrs. Mason and Slidell on their way to England on a diplomatic mission from the Confederate government. The steamer was stopped by the United States steamer San Jacinto, Captain Wilkes, and the two men were taken from on board of her and carried to the United States as prisoners of war in spite of the indignant protest of the British commander.

There is no principle of international law by which the action of Captain Wilkes can be sustained. The men were not soldiers or military persons going to join the enemy, but mere diplomatic agents sent to a neutral country, and therefore not capturable as contraband of war. And as to their dispatches: as we have already seen, whatever their contents might be, no responsibility attaches in the case of a mail steamer, which is therefore exempt from capture on that particular ground. If exempt from capture, she is also exempt from visit and search, for the right of visit and search, being merely auxiliary to the right of capture, must fall with it. Again, there could be no presumption that the dispatches were of a hostile nature, since their object may have been to solicit peaceful mediation by the neutral government to which they were addressed.

It is true that a technical right to visit is supposed to exist in all cases, as a belligerent's discretion cannot be restricted by any fixed rule. But this right is subject to one limitation. It is based on the possibility that the vessel to be visited may be found to be liable to capture, either from her being enemy's property, or from her destination, coupled with the nature of her cargo. Had the Trent been sailing, really or apparently, for an enemy's port there would have existed a possibility that she might be found to be liable to capture. In that case, under the general rule, Captain Wilkes's technical right to visit her could not be disputed. The Trent was known to be neutral property, and sailing not for an enemy's port, but from one neutral port to another. As for Mason and Slidell, they were known not to be military persons, and therefore not contraband of war. Thus the possibility of her being found liable to capture—the sole ground of the right to visit—was flatly negatived by the known facts of the case. Even assuming that the Trent was technically liable to visit and search, simply taking persons from on board of her and then letting her go, without the judgment of a prize court, which

she was entitled to have, was a gross violation of her nation's sovereignty. England's claim of right to do this very thing was one of the chief causes of our war of 1812. Thus in demanding reparation for Captain Wilkes's action she placed herself on precisely the same ground on which we stood before our war with her; so that on our own principles we were bound to accede to her demand for reparation.

If Captain Wilkes had brought in the Trent for adjudication, he would have clothed his conduct with an appearance of legality. In that case our own prize court, there not being the least scintilla of probable cause, would have restored the ship and held him responsible in damages; and had we not promptly made the reparation required, Great Britain would have had against us a just cause of war.

This leads us to another important topic: The Duties and Responsibilities of Captors.

I will remark in passing that a neutral nation may forbid prizes to be brought into its ports except under stress of weather, to leave immediately afterward.

Captors are personally liable in a prize court for a capture without probable cause. In such case the ship and cargo would be restored, and the captors mulcted in costs and damages. And even in case of condemnation, compensation would be made for any loss arising from the captor's want of care. At his peril he must place an adequate force on the captured ship with a competent prizemaster, for whose conduct he is responsible. But there is no responsibility for loss by the perils of the sea.

He must bring or send in his prize for adjudication without delay, and commence proceedings at once by a libel in the prize court. Should there be unnecessary delay in bringing in or in commencing proceedings, demurrage is allowed to the claimant. The rule is inflexible in regard to privateers, but a war ship may sometimes not be able to comply with it, being under orders which may detain her. Not only must the prize be brought in without delay, but it must be to the most convenient home port, otherwise the claimant's expenses might be unnecessarily increased.

Captured contraband cannot be appropriated, but must be brought in with the ship. Goods that are perishable or otherwise impossible to be brought in should be sold by the captors and

the proceeds delivered to the register of the prize court, and in case of necessity the prize itself may be sold, the proceeds being paid into court. If for any cause it cannot be brought in, it may be destroyed, the cargo and the ship's papers being saved if possible.

A cartel ship is used under a flag of truce for an exchange of prisoners, or for communication between the belligerents, and may be employed by any naval commander in the execution of his duties. She is regarded as neutral, and as such is held sacred. She should carry a white flag, together with her national one, but she must carry no cargo, and cannot be allowed to trade. She should carry one gun only, for use in signaling. Any abuse of her character would justify her capture.

We will now consider the proceedings in the prize court and their effect.

The adjudication must be made by the first admiralty court that obtains jurisdiction by a commencement of the proceedings. The court must be only of the captor's own nation, or of its ally in the war. Although in a suit *in rem*, a court, in order to exercise jurisdiction, is supposed to have the *res*, or thing in controversy, in its possession or under its control, a prize court may assume jurisdiction, though the prize may be lying in a neutral port, in which case it is deemed to be under the captor's control, and his possession is deemed to be that of his government.

The burthen of proof in all cases is on the captor.

Capture overrides all previous liens on the property, always excepting a bottomry bond on the ship and respondentia on the cargo, because these saved the ship's life. Were these liens not always respected, this means of saving ship and cargo would hardly be obtainable anywhere. When the cargo only is condemned, the ship being restored, the shipowner is allowed his freight, it being a lien on the cargo; but it will go to the captor if it is he that has carried the cargo to the place of destination. Subject to these charges, the captor takes the interest of the owner at the time of shipment without regard to any subsequent transfer or lien except as before mentioned.

It is important to bear in mind that mere capture does not transfer the ownership. Nothing can do this but the judgment of a competent court, the title meanwhile remaining in sequestration.

The law of the sea no single nation can change, and a prize court is therefore bound by the established rules and usages of maritime nations; but, under international law, the judgment of a prize court, whether correct or incorrect, is always held conclusive as between the parties, and a decision would be held valid under international law as construed by the captor's court. But although an unjust judgment of condemnation may bind the claimant, it does not bind the claimant's nation nor preclude it from demanding reparation from the captor's government, whose responsibility commences immediately on the rendition of a judgment in denial of justice.

No condemnation can be made after the war is ended. If peace finds the prize uncondemned, it must be restored.

Next, as to prize money: The established theory is that all prizes belong to the sovereign, so that the national government may lawfully restore the prize either before or after condemnation, and the captor would have no redress except by an act of the legislature. In the United States the prize money is distributable as Congress may direct.

There is no general rule as to the proportions in which prize money will be distributed among the respective claimants, this depending on the rules and usages of the different maritime nations. Our own prize courts follow in this respect the rules and usages of those of Great Britain. Under our act of Congress of 1800, when the enemy was in equal or superior force, the whole goes to the captors; if in inferior force, one-half goes to the United States and the other half to the captors.

It has been adjudged that when a naval officer not belonging to the capturing ship is on board only as a passenger, although acting in his official capacity, there is no rule that entitles him to share.

In the case of a joint capture, if the vessel claiming to share was in any degree instrumental in effecting the capture, this entitles her to share. In order to share she must have been at the least in sight before the surrender. In that case it will be presumed that she contributed to the capture either by adding to the fear of the enemy or by encouraging the captors; but this presumption is not made in favor of a privateer claiming only on the ground of having been in sight; for the reason that privateers are fitted out only for private gain and are under no obligations

to attack, whereas a war ship is always bound to do so, except when the enemy is in greatly superior force. So that the fact of a privateer being merely in sight is not supposed to encourage the captors or to add to the enemy's fear.

One other topic remains to be noticed—that of Salvage on a Recapture.

Among all maritime nations salvage is given to the recaptors, but as to the rate of salvage there is no uniform rule prevailing among them. Our act of 1800 (U. S. R. S., sec. 4652) specifies various rates of salvage according to the circumstances. It discriminates in favor of privateers. The reason of this discrimination is, no doubt, that a privateer is under no obligation to recapture, while a national ship in recapturing is simply doing its duty, for which officers and crew are being regularly paid by the nation.

When the recapture was not made until after the owner's title had been divested by the sentence of a competent court, there can be no restitution, and, consequently, no claim for salvage. But in the case of a recapture from pirates, restitution with salvage is always given, because there could never have been any valid change of title.

There is one case in which salvage is refused on a recapture. It is when the vessel had been unlawfully seized by the original captors. It is then presumed that there would have been a decree of restitution by the captor's own prize court, so that there never was any real danger of condemnation, and consequently the recapture not having conferred any real benefit on the owner, there is no ground for the payment of salvage. I should call this reasoning rather ingenious than satisfactory. In the early days of the French Revolution, however, this principle was not applied to captures by French cruisers, inasmuch as the French prize courts in those anarchical days were notoriously condemning without regard to the rules of international law, and accordingly in those cases salvage was usually decreed.

In concluding, I am tempted to make a remark, however paradoxical it may seem. It is this: That in these latter days a knowledge of certain branches of international law is of more importance to naval officers than to the diplomatists who represent us abroad, and for this reason, diplomatists nowadays are never compelled to make an instantaneous decision on any important

question. When a decision is to be made they have at hand all the books and authorities needed to enable them to arrive at a correct conclusion, and in all cases they can promptly receive by telegraph such instructions from their government as will free them from all responsibility. On the other hand, a naval commander may at any time be called on for instantaneous action that may possibly involve his country in war, with no time or opportunity to consult authorities, and in a place where no telegraphic communication with his government exists.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NAVAL RAIDS: A CURSORY EXAMINATION AND A CONCRETE EXAMPLE.

By Captain C. F. Goodrich, U. S. N.

Incident to a serious naval demonstration against the United States is the possibility that exposed points may be selected for sudden attacks, of which the object is rather (a) the destruction of ships either close to the coast or in port, or (b) damage to structures on shore with the alternative of heavy indemnity, than the winning of any military advantage. Such operations are, moreover, not restricted to occasions when a superior supporting force is in the neighborhood, but may be, as they have been, undertaken by solitary cruisers from a remote base. In discussing the aspects of raiding, it will conduce to brevity and clearness to separate the cases described and to take up first the simpler of the two. Our proposition may then be thus stated: "Given a reasonably complete command of our own water approaches, are such isolated raids to be apprehended, and, if so, how may they be best guarded against?"

Of the illustrations and precedents available, those are naturally the more valuable which relate to our own shores and, in point of time, lie within the period of steam propulsion. A study of such precedents will prove helpful in indications as to what should be done under somewhat similar circumstances, and may make clear certain principles applicable even when we are unreservedly on the defensive.

The literature of the raids by Confederate cruisers along our Northern seaboard is so full that we experience difficulty only in selecting what is most pertinent. In the following extracts attention is called to the mental side of the question, as reflected

in the alarms of the mercantile community; the pressure brought to bear upon the Government to appease these alarms; the real damage done; the measures adopted to put a stop to the damage.

As early as May, 1861, the Governor of New Jersey writes to President Lincoln that "The citizens of New Jersey residing in the southwestern part of the State and on the Delaware bay feel some anxiety on account of their defenceless condition and exposure to annoyance from privateers."

In July of that year the Jeff Davis, privateer brig, created a panic in the coastwise trade by her captures of vessels off Nantucket Shoals and Cape Hatteras. The Navy Department was inundated with reports of her activity, and requests for vessels to go in chase poured in from underwriters, private individuals and others. Such naval ships as were available were dispatched in pursuit, and private steamers were also engaged for this service. One telegram will suffice to show the Department's methods:

July 12, 1861.

Send any vessel you can find or hire after the privateer reported southeast of Nantucket.

Gideon Welles, Secretary of the Navy.

To Captain Breese, Navy Yard, New York.

In all, some eight or ten vessels were dispatched in pursuit, but without success. The Jeff Davis got safely back into the Confederacy after capturing four coasters.

Governor Andrew, of Massachusetts, addressed, on July 16, 1861, a long letter to the Navy Department upon the necessity of cruisers to protect coastwise commerce. Being typical of many others of like import from many sources, I quote some of its expressions *in extenso:*

In view of the exploits of Southern privateers within the past few days off our coast, a feeling of apprehension has come to pervade our mercantile community, surpassing anything which it has experienced during the progress of hostilities thus far. There is serious trouble among all our insurance companies, caused by the actual presence of a danger which they had confided in our naval efficiency to avert, and there exists throughout every branch of trade which is connected with our shipping an uneasiness which finds vent in anxious looks and words and expressions of indignation that the most stringent measures are not adopted to strengthen the blockade and to scour any privateer from our seas.

The Confederate privateer steamers Gordon and Mariner, about the same time captured the first the brig Wm. McGilvery and schooner

Protector off Hatteras, the latter the schooner Nathaniel Chase off Ocracoke Inlet. The privateer York took the brig B. T. Martin. These events brought to the Navy Department letters from the marine insurance companies of Philadelphia, beseeching more activity and better protection.

On the 12th of November, 1862, the Board of Trade of Boston addressed a communication to the Secretary of the Navy calling his attention to the defenceless state of that harbor and pointing out its liability to raiding by the Alabama, lately reported as not far distant, or by one of the rams then building in England for the Confederacy. They say: "It is believed by practical men that through Broad Sound (one of the two principal entrances to this harbor) a reckless and daring piratical ironclad steamer might enter without serious injury and lay our city under contribution. . . . In view of the foregoing facts, we beg respectfully to suggest that the new ironclad steamer Nahant (of the monitor class) now nearly completed by Mr. Loring, be allowed to remain in this harbor for its defence, at least till the necessary guns are placed in the several fortifications of this harbor and the pirate Alabama has been either captured or destroyed."

The following correspondence accentuates the pressure brought to bear on the Navy Department for local needs:

Albany, N. Y., September 16, 1862, 5.30 p. m.
(Received Washington, 6.30 p. m.)

Sir:—If there is anything in the statement of the New York World this morning in reference to rebel vessels, and I have information from a respectable source which goes to corroborate it, I am sure that the new ironclad Government steamer can be put to no use more important for all interested than by placing her at once in New York harbor, which I earnestly request. E. D. Morgan, Governor of New York.

Hon. Gideon Welles.

Navy Department, September 17, 1861.

The steamer referred to is probably the New Ironsides, now at Philadelphia, where her presence is most earnestly requested by Governor Curtis. The Galena and Monitor are guarding the entrance of the James River in anticipation of Merrimack No. 2. Under these circumstances it would seem to be impossible to comply with your request.

Gideon Welles.

On November 8, 1862, Governor Morgan writes the Secretary of the Navy urging that the Savannah be stationed in the North river ,and that an ironclad be sent to New York.

November 12, 1862, the Boston Board of Trade wrote the Secretary of the Navy that the Nahant, just completing at Loring's yard, should be kept in Boston harbor, to protect it

against the incursions of the Alabama or other rebel vessels—the forts being but indifferently armed with 153 out of 475 guns allotted.

This letter was endorsed:

There is always some naval force at Boston, while other places on the coast, with the exception of Portsmouth, are not so favored. Were a cruiser to enter the harbor of Boston, which is very improbable, there is always a force to see to her. It can hardly be supposed that an armored vessel prepared for operations elsewhere should be detained at Boston and the expedition broken up under a remote apprehension that a hostile vessel might attempt to visit that place. G. W.

Albany, November 17, 1862.

I had just been informed that Rear Admiral Paulding was satisfied that the Savannah was unsuitable for the service specified. Accordingly you wisely determined that the Roanoke should be placed at the disposal of the Rear Admiral immediately on her completion as an ironclad. In the meantime you directed that one of the present ironclads be left to the harbor until the Roanoke is completed.

E. D. Morgan, Governor.

Hon. Gideon Welles.

Boston, November 18, 1862, the Boston Marine Society repeats the wish of the Board of Trade for an ironclad at Boston:

Telegram.

New York, November 20, 1862.

We respectfully request that the Passaic remain for the defence of this harbor until the Montauk is ready for that service.

E. D. Morgan, Governor.
Henry Barney, Collector.

Hon. Gideon Welles.

Telegram.

Boston, 2.40 p. m., February 2, 1863.

From last reports concerning the Alabama the intelligent Boston merchants believe it is not improbable that Semmes may make a descent on the Massachusetts coast, say at Provincetown, which is wholly unprotected, and suggest that an armed Federal vessel should be stationed there.

Jno. A. Andrew, Governor of Massachusetts.

Hon. Gideon Welles, Secretary of the Navy.

Commonwealth of Massachusetts,
Executive Department, Boston, April 27, 1863.

Sir.—I beg to request you to consider the importance of detailing immediately an ironclad vessel of war for the exclusive duty of protecting the harbors of the Massachusetts coast, and particularly the harbor of Boston.

(Here follows arguments as to extent and value of property exposed, etc.)

Not a single Federal vessel of war cruises in Massachusetts Bay for the protection of its coast and commerce, nor has the Federal commander at Fort Warren any authority to detain and examine suspicious vessels, or any steamer or cutter with which to execute such authority if it should be conferred on him; and the same want of protection is true of the southern Massachusetts coast, where through the Vineyard Sound 90,000 vessels have been counted as passing Gay Head in the course of twelve months.

. . . with those channels (Boston harbor) open to the commerce of the world, a daring commander of a single swift ironclad steamer like the Alabama, can undertake with a fair prospect of success, to suddenly run past the forts and appear before the city.

. . . . With our forts, therefore, so inadequately armed, the only efficient protection Boston harbor can have against the possible incursion of a single swift rebel steamer is by stationing here a Federal ironclad vessel which would be able to attack and sink such a rebel steamer when it should have entered the port.

. . . . I most respectfully but firmly urge upon your attention as a matter of right that such a vessel may at once be assigned to this duty. If it is a question of pecuniary consideration to the Federal government, I am ready and hereby offer to buy such a vessel from the United States and to pay for it immediately in cash.

The anxiety of the whole community for protection from sudden incursion by sea, the vast material interests at stake, and my own consciousness of the reasonable character of my request unite to induce me to ask an early reply to this communication.

John A. Andrew, Governor of Massachusetts.

The President of the United States.

The following day Governor Andrew addressed a letter of similar import to the Secretary of the Navy, in which he says:

I am after many days of careful exploration compelled to the conclusion that the only act of possible of immediate utility and likely to impart early relief to the public mind is to procure the assignment of an ironclad steam vessel, with its complete armament ready for any service to the separate defence of our principal harbor.

The same day he wrote to Senator Sumner to urge the Department to equip and station the Ohio at the mouth of the harbor at once, pending the arrival of the ironclad.

Navy Department, May 2, 1863.

Sir.— . . . Among the suggestions urged by you on the consideration of the Federal Government is one for an ironclad steamer to be stationed

at Boston. We have not, however, a vessel of this description that can be spared from other duty and appropriated to that object at this time. Nor, with due deference, do I think that such a vessel is the best adapted to the coast defence of Massachusetts and New England, although it might be more useful, perhaps, in the harbor of Boston, should a roving privateer or pirate make its appearance at that port. But the turreted vessels which we have, while admirably adapted for harbor defence and operations on the coast, are not vessels of speed, and therefore would not be efficient, except at a single point. It has appeared to me that to guard against the improbable but possible contingency of a hasty descent by one or more of these rovers upon some unprepared place upon the coast, it might be a wise precaution to have a fast cruiser stationed at Boston and always prepared for service. Such a vessel besides affording security for Boston and its immediate vicinity, would, on receiving intelligence from any place on the coast by telegraph or otherwise, proceed at once to the scene of the danger, and with a probability of capturing the invader.

For the extensive coast of New England such a vessel would be more efficient than one of the ironclads. We can at this time ill spare one of the fast cruisers for such a service, but it may be a wise and advisable precaution demanded by the great population and interests involved. The Department will therefore make it a point to have a cruiser stationed at Boston.

Your suggestions, made through Senator Sumner, that a battery be placed on the *Ohio* shall have immediate attention, and though we cannot fit her for cruising, she will afford additional security to Boston. . . .

Gideon Welles, Secretary of the Navy.

His Excellency John A. Andrew, Governor of Massachusetts.

June 19, 1863, the New York Harbor and Frontier defence Commission passed resolutions relating to New York harbor, sent to Secretary of the Navy through Senator Morgan.

Navy Department, June 26, 1863.

Sir.—In reply I would say that there are no ironclads at present available for service in New York Harbor. All now in condition for active operations are needed on our blockading stations, which are threatened from both without and within. The Roanoke is under orders to Hampton Roads, where her presence is deemed of importance.

Gideon Welles.

Hon. E. D. Morgan, New York.

On May 4th Governor Andrew renewed his request for an ironclad, and on May 7th Secretary Welles replied, "there is no vessel of that class at this time available."

It is impossible, in reading the letters and telegrams quoted above, not to admire the wisdom and firmness displayed by the

Secretary of the Navy. A weaker man could not have withstood the popular clamor arising in every seaboard town for local protection, but would have divided our too scanty forces and have made the less important points secure at the sacrifice of the larger, the vital interests at stake. Mr. Welles' contention was, in effect, that the harbors of New York and Boston were guarded by the vessels of the blockading fleet which stretched from Cape Henry to the Rio Grande, a surprisingly broad and sound strategic view, from which he appears never to have wavered. This view, the very essence of correct coast defence, stood successfully the test of years of war. Given fresh conditions not too unlike the old, it will still prevail. Yet to-day we hear on all sides a noisy demand for harbor-defence vessels and batteries of 16-inch guns on every salient.

That Mr. Welles should have consented to the placing of a cruiser in Boston and a monitor in New York must not be regarded as a surrender on his part of the military principles for which he did battle, but rather as a proof of the magnitude and volume of the cry for help from those who were in a position to somewhat dictate the form this help should assume. It was like the bending to the blast which saves the tree from destruction.

Whether, in the event of war in these days, a Secretary of the Navy can possibly be as independent in his action as was Mr. Welles, it is difficult to say. The question is of great importance to us, although it hangs rather upon the sociological development of the country than upon naval policy. Personally, I am disposed to fear that the powers of the press and the politician will, together, overbear the future Secretary and force him into abandoning, not the true faith itself, but its practice. It is incumbent upon all who seriously discuss the naval problems of the future to recognize the possibilities for evil which may, and doubtless will, flow from the source so clearly defined in these extracts from the history of the past.

I purpose illustrating by an example drawn from an event of the Rebellion the method of apprehending a raider, which it will be our duty to *avoid*, and thus incidentally and *per contra*, to point out the measures which seem better adapted to the end in view.

The Tacony Episode.

The summer of 1863 was characterized by a raid which for boldness and success must long remain notable in naval annals. The narrative, most interesting and instructive, will first be briefly given, and then the lessons it contains will be pointed out with reference to the general question with which we began the study of this species of warfare.

In May of that year the C. S. S. Florida was preying on American commerce off Cape San Roque, Brazil, in the fair way through which must pass all sailing vessels crossing the equator in the Atlantic ocean. It may be remarked, parenthetically, that this point might with propriety have been guarded by one or more of our own ships. On the 6th she took the American brig Clarence. Second Lieutenant C. W. Read, of the Florida, then made a suggestion to his commanding officer in these words, "I propose to take the brig which we have just captured, and with a crew of twenty men to proceed to Hampton Roads and cut out a gunboat or steamer of the enemy.

"As I would be in possession of the brig's papers and as the crew would not be large enough to excite suspicion, there can be no doubt of my passing Fortress Monroe successfully. Once in the roads, I would be prepared to avail myself of any circumstance which might present for gaining the deck of an enemy's vessel. If it was found impossible to board a gunboat or a merchant steamer, it would be possible to fire the shipping at Baltimore."

This proposition was approved, and Read, placed in command of the Clarence, immediately sailed for the Chesapeake. He had but one gun on board—a howitzer. Arriving off the Carolina coast a month later he burned or bonded three American vessels. In the meantime he had become dissatisfied with the Clarence's sailing qualities. From his prizes he learned that a rigid examination was made of all craft approaching Hampton Roads, and that none were permitted to pass Fortress Monroe except those freighted on Government account. His scheme being therefore impracticable, he "then determined to cruise along the coast and to try to intercept a transport for Fortress Monroe and with her to endeavor to carry out the orders of Commander Maffitt, and in the meantime to do all the possible injury to the enemy's commerce."

On the morning of June 12th, when about fifty miles east of Cape Henry, he captured the bark Tacony, by hoisting false signals of distress that brought her within hail, transferred his crew and howitzer to her as being the faster vessel, and burned the Clarence. At the same time he burnt one schooner, the Shindler, and bonded a brig and a schooner. The latter was made into a cartel. She brought the Clarence's prisoners into Philadelphia, as well as the news of the Tacony's conversion into and presence as a privateer.

The Tacony then stood off shore into the track of the homeward-bound West India trade. On the 15th, being about 250 miles east of Cape Charles, she burned a brig. Thence she went toward Nantucket, where, on the 20th and 21st, that island being about northwest and sixty miles distant, she burnt a clipper ship, from London to New York, a bark and a Liverpool packet on the 22d in 41° 3′ N., 69° 15′ W. Until the 23d she seems to have remained in the neighborhood of George's Bank, burning fishing vessels to the number of eight. On June 24th she had reached to the northward into the track of vessels bound into Boston from Europe, where she bonded an emigrant ship and took the fishing schooner Archer, Portland, bearing west by north 110 miles.

Read says: "As there were now a number of the enemy's gunboats in search of the Tacony, and our howitzer ammunition being all expended, I concluded to destroy the Tacony and with the schooner Archer to proceed along the coast with the view of burning the shipping at some exposed harbor or of cutting out a steamer. Accordingly, on the morning of the 25th of June we set fire to the Tacony, and with the Archer stood in for the coast."

Learning that the revenue cutter Caleb Cushing was in Portland and that a staunch, swift propeller would remain there during the night he determined to run in and seize both. He entered the harbor unchallenged at sunset June 26th. His engineer expressing doubts as to his ability to start the engines of the steamer, and the enterprise demanding successful results before daylight, he abandoned the notion of taking the steamer, resolved to capture the cutter, and after getting from under the guns of the forts, to return and burn the shipping. Easily and quietly he boarded the Caleb Cushing and with her stood out to

sea. The wind, however, failed him toward morning of the 27th, so that he was readily overhauled by two large steamers and three tugs with United States troops on board sent out in pursuit. He set fire to the Cushing, took to his boats and at 11.30 surrendered to the Forest City.

On the other side we have a record of alarms seldom paralleled in our history. The telegrams to the Department began to arrive on June 13th, the day after the capture of the Tacony off Cape Henry, and poured in with little cessation during the succeeding fortnight.

The Secretary of the Navy telegraphed the commandants at Boston, Philadelphia and New York: "Charter or seize half a dozen moderate-sized, fast vessels; put on board an officer, a dozen men and one or two howitzers; send them out in various directions. Take any vessel that can be sent to sea within the next forty-eight hours." To Rear Admiral Lee, at Hampton Roads: "Send out anything you have available." Again, on June 24th, the Department telegraphed to the commandant, Boston: "Charter more steamers and send them out after the Tacony; all that can be sent in forty-eight hours. G. W." Phenomenal activity reigned in naval circles and every suitable vessel that could be had in any way was dispatched on the track of the Tacony.

The chase after the Tacony can best de described graphically.

The markings on the charts give the positions of the Tacony and of each of the vessels sent in chase at noon of each day. A sharp distinction must be drawn between those positions which are of official record and those which are only estimated. The former are beyond controversy. The latter must be taken as merely the best guesses made after careful study of the orders governing the movement of the vessels concerned and the cruising reports returned. The log-books of regular United States cruisers are alone available at this time. The reports of chartered vessels are generally devoid of all statements as to latitude and longitude. An occasional reference to the speaking of another ship affords the only check on the guessing. My readers must be content to take such estimates under the qualification mentioned. I feel confident that in most cases they are not very far wrong. Some vessels sent in pursuit I have omitted altogether from these charts, not feeling justified in hazarding my opinion as to their whereabouts. For the table of noon positions

of the naval vessels I am indebted to the courtesy of Lieutenant-Commander Rush.

It seems incredible that a sailing craft of only average speed should have cruised against our coastwise traffic in so successful a manner, and have enjoyed from first to last, a period of two weeks, complete freedom from interruption by the forty odd vessels, most of them steamers, sent in pursuit. The fact demonstrates afresh the difficulty of finding a ship on the ocean when her course and destination are unknown, and emphasizes the necessity, if practicable, of arresting her at the place of exit. The inference from the occurrence itself, supported by the evidence of the track charts, shows a misuse of the force employed in patrol. At times the Tacony must have been perilously close to her pursuers.

The Blackstone reported that she had twice been near the Tacony, but that the two vessels were concealed from each other, in one instance by the darkness of the night and in the other by the obscurity of fog. Thick weather prevailed. This episode answers affirmatively the first query of our opening, as to whether such raids are to be apprehended. It would be equally valid in the face of a hundred cases tending to prove the contrary.

To consider the individual instructions issued to the cruising vessels would consume too much time and bear little fruit, but a hasty glance over them reveals the lack of a well-defined scheme calculated to cover the ground in a thorough and efficient manner. Admiral Lee was restricted to the waters south of the Capes of the Chesapeake, but the commandants at Boston, New York and Philadelphia were apparently unhampered, for they sent vessels in any and all directions. In consequence, the ships cruised in a haphazard manner, large gaps were left in the patrol line, while at other points there was an undue accumulation of force. As a result, the Tacony was not apprehended. Had the task of searching been divided between the four bodies of ships, each with its own allotted ground to examine and protect, and had a central authority directed the movements of all, it is yet possible that failure would have occurred, still the chances of success would undoubtedly have been increased. That Read's party was finally captured is no excuse for her continued immunity from detection. The ships sent out rushed madly in all quarters, burnt up their fuel with all possible dispatch, broke down their engines and had to put back to port for coal and repairs. Less

activity in the fire-room and more expenditure of brain tissue in devising a consistent and simple scheme of patrol, assigning to each ship its geographical square to cover under reduced speed, or her due place in scouting line would have probably yielded better results. One is free to recognize the parallelism between this episode and the chase after the Confederate cruisers Alabama, Florida, etc. We were invariably sending ships after the latter and to the ports they had just quitted, and we were, of course, always just too late to catch the bird that had flown. The records show that no plan of guarding certain strategic points—where the streams of ocean commerce mingle or cross, and there affording protection to the sailing ships that must, of necessity pass through them—yet it is at these very points our merchant vessels were mostly captured and destroyed. Each captain went largely on his own judgment and measured the success of his cruise by the number of miles travelled.

Nothing is more clearly demonstrated by the Tacony's cruise than the need of some central control. And had the Government profited by the warning it thus received and established some such off-shore guard to its coastwise trade, the careers of the Florida and Tallahassee in the following year would have been marked by fewer burnings of American ships, while they might, indeed, have been brought to a sudden close. The Florida passed rapidly along our shores, did what damage she could, and then stretched over to the Azores. Some of us remember the excitement she aroused and our own share in the wild-goose chase after her. The Tallahassee in ten days burned, scuttled and bonded thirty-one vessels, and returned to Wilmington after an absence of twenty days consumed in the dash along the coast to Halifax and back.

Taking up the second of our initial queries, "How may such raids be best guarded against?" we must rely upon the principles already deduced as governing the operations of scouting, for they are equally applicable to the problem which now concerns us. The postulate, it is to be remembered, is our own reasonably complete control of our water approaches. The rules we have evolved call for scouts steaming at convenient speed in two lines, an outer and inner, separated by a distance equivalent to that traversed by an average vessel in twelve hours, so that the raider must cross one zone of daylight within sight of one or other of the patrol lines.

In this way our coasting trade would be hedged in and protected as effectively as possible, the occasional movements of the scouts to coaling and signal stations serving to guard the space included between the patrol lines and the beach. In addition, small cruisers might be placed at points, of which Provincetown is the type, ready to move in any direction on telegraphic summons to the relief of a threatened port.

How Guard Against Raids?

II.

The problem assumes a very different guise, however, when, the postulate being changed, we are thrown wholly on the defensive. In this case, our coasting vessels will have been withdrawn from the seas and our duty have been restricted to the attempt at warding off the attacks of single cruisers upon isolated and exposed points deficient in local defence. The question evidently hinges upon the completeness of the enemy's investment. If he be present in such overwhelming force as to contain our main fleet and in addition to establish an adequate watch over our fortified harbors, we shall be powerless on the water, at least, to oppose effectual resistance to the blows contemplated. Such points must then look to the army for shore works that will keep the enemy's lighter vessels off at harmless distance. These works need not be elaborate or heavily armed. Hasty earthworks and a few six-inch modern rifles, for example, will abundantly serve. As against landing parties, the regular or State troops will suffice. It is simply a question of the most profitable use of the means at hand. All points cannot be protected; some must be left exposed. The army must incur the obligation of selecting the sacrificial lamb.

Between the two extremes we have considered comes the quite probable mean, which may be thus defined: "Given to the enemy a great but not overwhelming naval superiority, how can we best guard against raiding?"

It will be wisest, in my opinion, to throw this burden upon the army entirely, for it will be difficult to spare any of our ships from their more important duties. Such a measure, however, would not be approved by public opinion, which, after all, rules in our land. The Navy Department would be unable to resist

the appeals from governors, mayors, chambers of commerce, boards of trade, insurance companies, and the politicians, who never lead and direct the general sentiment, but follow it at a short distance astern. In this world it is the expedient which control men's actions, not the intrinsically desirable—and popular clamor must and will be appeased.

In apportioning the means to the end, the first consideration is the size of vessels that the enemy can employ on raiding duty. This will be determined by the depth of the water approaches. If the towns are exposed, like Galveston, or if the harbors are deep and roomy, the cruisers of the enemy may be of the larger type. If the water be not deep, if the harbors be narrow and limited, or the towns back from the coast, the cruisers will be of the smaller type. Our admiral must select for his guard ships cruisers not less in power than those likely to be sent in by the enemy, assigning each to a certain district or division of the coast line. A *sine qua non* is a safe refuge behind stout shore works. Lacking this refuge, he may lose his ships by a descent in force. If each section of the line to be guarded were provided with two or more such shelters, the security of the patrol ship would be greatly increased, as it would always have one point within easy reach. Local conditions will govern, of course. The ideal combination is a swift cruiser of adequate force, a short patrol line, a central station, and harbors of refuge on each flank. In practice, much that is desirable will be lacking, and the best must be made of the actual circumstances. The possession on our part of an efficient system of lookout and signal stations connected by telegraph and telephone with the central post of the patrol will enable the latter to watch a comparatively wide stretch of coast.

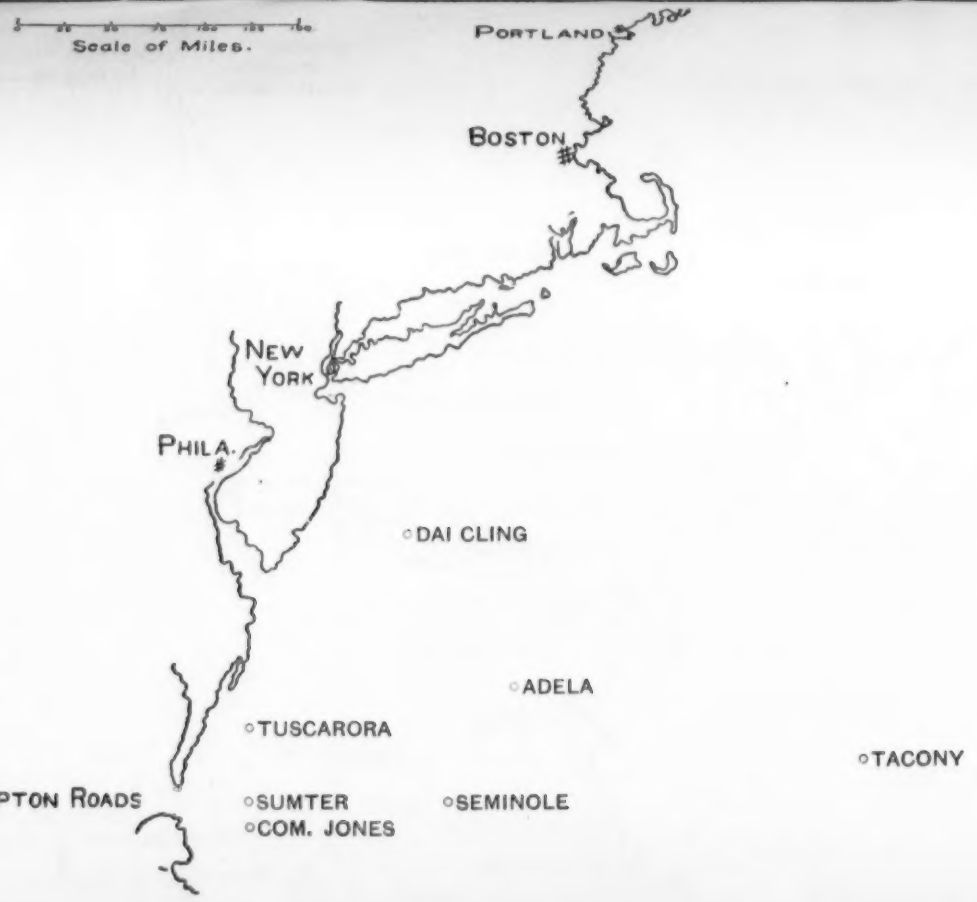
Vigilance and prompt action may prevent such raids as are contemplated, or catch the raider red-handed. More complete means of prevention and protection are barred by the conditions of the problem. When we shall have quickly detected the presence of the raider and have started at once on his tracks we shall have done all that our scanty resources in ships have rendered practicable. Success may not crown our efforts, and popular dissatisfaction will then be aroused against the Navy. Our indifferent reward will be found in the reflection that we have done the best we could and have failed because no other result was attainable.

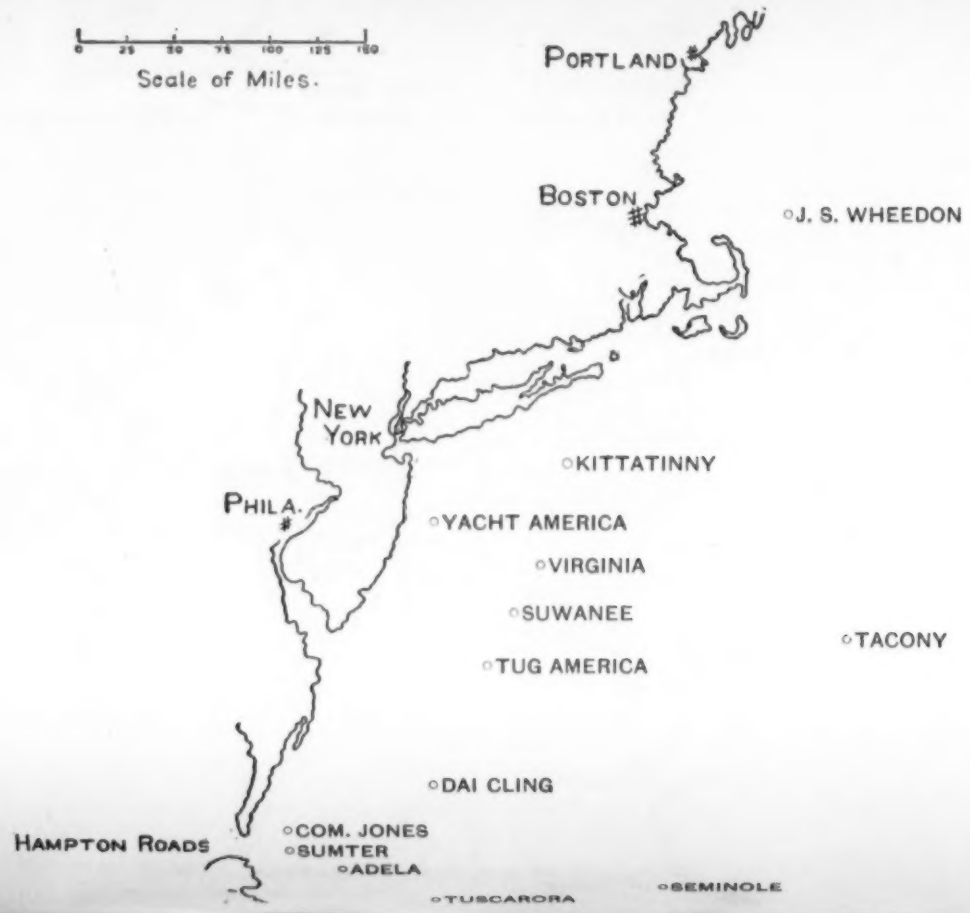
Name of Vessel.	Sailed From.	Date.	1863.—Noon Positions on June												
			15th.	16th.	17th.	18th.	19th.	20th.	21st.	22nd.	23rd.	24th.	25th.	26th.	27th.
Adela	New York	June 14th	37-59′ 73-12	36-48′ 75-23	36-37′ 75-04	38-25′ 74-41	Hampton Roads.	37-09′ 75-29	35-56 73-50	35-59 74-20	33-53′ 76-33	33-26′ 78-09	Port Royal.	Port Royal.	Port Royal.
Commo. Jones	Norfolk	June 14th	Off Capes of the Chesapeake, in sight of Cape Henry.				Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.
Dai Cling	New York	June 14th	39-13 73-48	37-19 74-18	36-38 74-43	Off Cape Henry.	Hampton Roads.	Newport News.	Newport News.	Newport News.	Newport News.	Newport News.	Newport News.	Newport News.	Newport News.
Ethan Allen	Boston	June 23d										21-44 68-15	40-57′ 66-26	40-53′ 65-44	41-53′ 65-40
Iron Age	Boston	June 25th												Broke Down.	Broke Down.
James Adger	Port Royal	June 20th							34-05 76-25	Hampton Roads.	Hampton Roads.	Off Cape Henlopen.	Philadelphia.	Reedy Island.	Off Cape Henlopen.
Kittany	New York	June 15th		40-25 72-45	39-35 71-33	40-08 69 33	40-26 68-35	40-30 67-34	40-45 67-30	40-30 67-00	40-40 66-15	41-12 65-12	41-24 63-06	41-45 61-43	42-36 60-58
Marion	New York	June 16th			Off Sandy Hook.	40-00 72-03	Off Sandy Hook.	Sandy Hook Bay.	Off Battery, N. Y.	Off Battery, N. Y.	Navy Yard.	Navy Yard.	Navy Yard, N. Y.	Navy Yard, N. Y.	Navy Yard, N. Y.
Montgomery	Boston	June 17th			41-56 69-45	40-49 69-59		40-40 71-13	41-12 70-58	40-58 69-09	41-17 68-15	41-09 69-27	41-09 69-38	41-45 69-08	41-05 67-30
Sabine	New York	June 16th			39-18 72-33	38-04 70-27	36-42 69-02	35-00 64-58	33-51 62-48	32-46 62-10	31-51 60-14	31-20 59-20	30-21 60-15	28-51 61-40	27-37 62-02
Seminole	New York	June 14th	37-01 74-05	35-30 72-15	36-37 74-49	37-59 72-58	36-54 73-47	38-31 75-00	Philadelphia.	Philadelphia.	Philadelphia.	Philadelphia.	Philadelphia.	Philadelphia.	Philadelphia.
Shenandoah	Philadelphia	June 26th													40-30 72-25
Sumter	James River	June 14th	Off Capes of the Chesapeake.		37-05 75-35	36-40 75-50	36-45 75-35	36-59 75-42	Horse Shoe Shoal.	Off Capes of the Chesapeake.		Sunk by collision with the Gen. Meigs, June 24th.			
Tuscarora	New York	June 14th	37-35 75-16	35-36 73-29	34-35 70-32	33-49 68-10	35-02 69-20	35-30 71-30	36-32 73-32	Off Cape Henry.	Newport News.	Newport News.	37-55 75-07	39-09 70-12	39-59 68-14
Virginia	New York	June 13th		39-30 73-05	36-21 70-02	35-50 70-02	34-09 68-17	33-40 65-25	32-33 70-00	30-00 69-55	27-49 70-23	27-49 73-07	27-52 73-49	29-02 77-27	30-53 79-20

June 12.

0 25 50 75 100 125 150
Scale of Miles.
PORTLAND
BOSTON
NEW YORK
PHILA.
HAMPTON ROADS
TACONY CAPTURED BY CLARENCE

HAMPTON ROADS ○TACONY CAPTURED BY CLARENCE





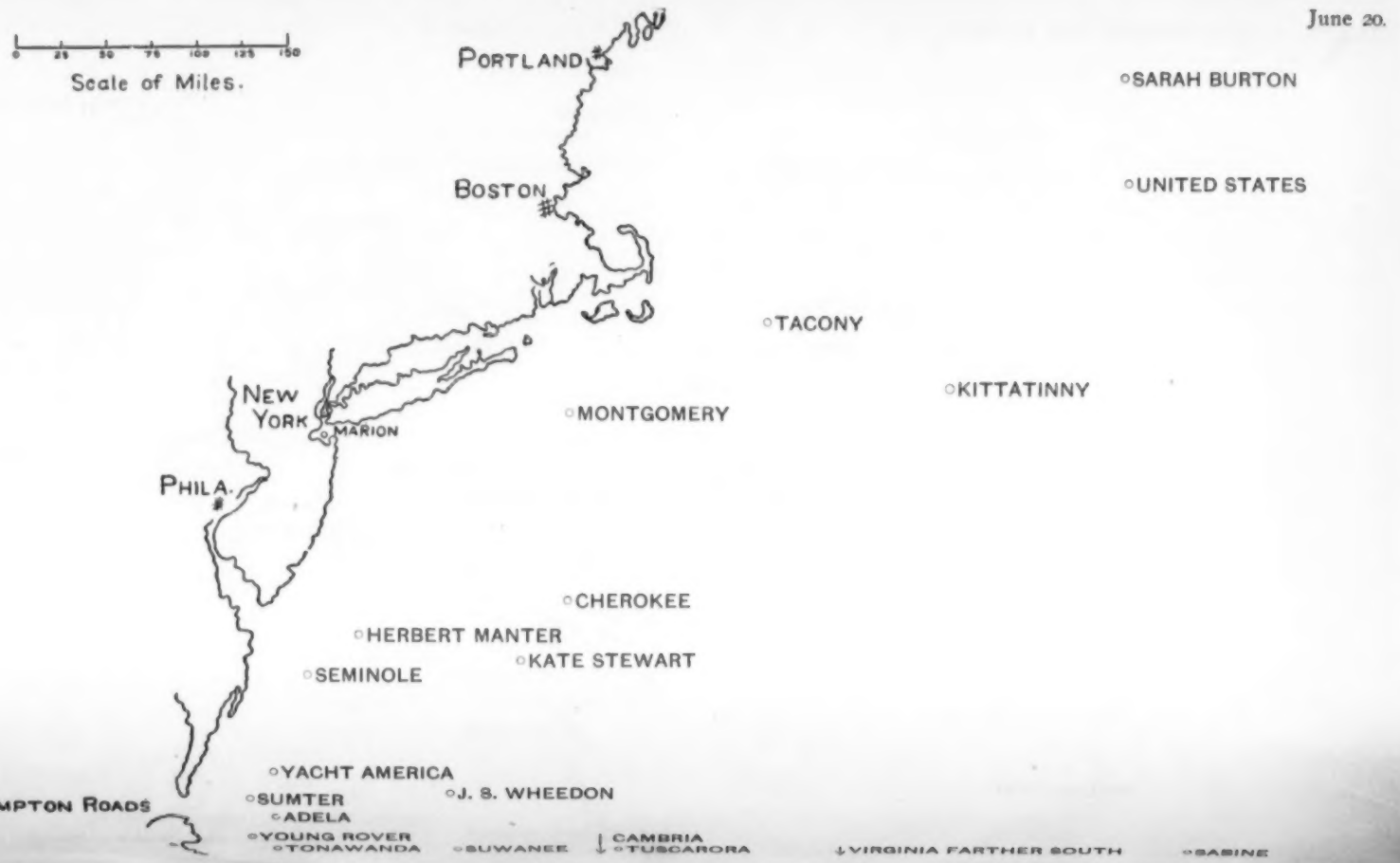
June 16.

June 17.

Scale of Miles.
PORTLAND
BOSTON
AMY
CHEROKEE
HERBERT MANTER
MONTGOMERY
NEW YORK
J. S. WHEEDON
BLACKSTONE
KITTATINNY
MARION
PHILA.
SABINE
SUWANEE
YACHT AMERICA
TACONY
KATE STEWART
TONAWANDA
SUMTER
HAMPTON ROADS
COM. JONES
DAI CLING
SEMINOLE
ADELA
VIRGINIA
↓ TUSCARORA FURTHER SOUTH

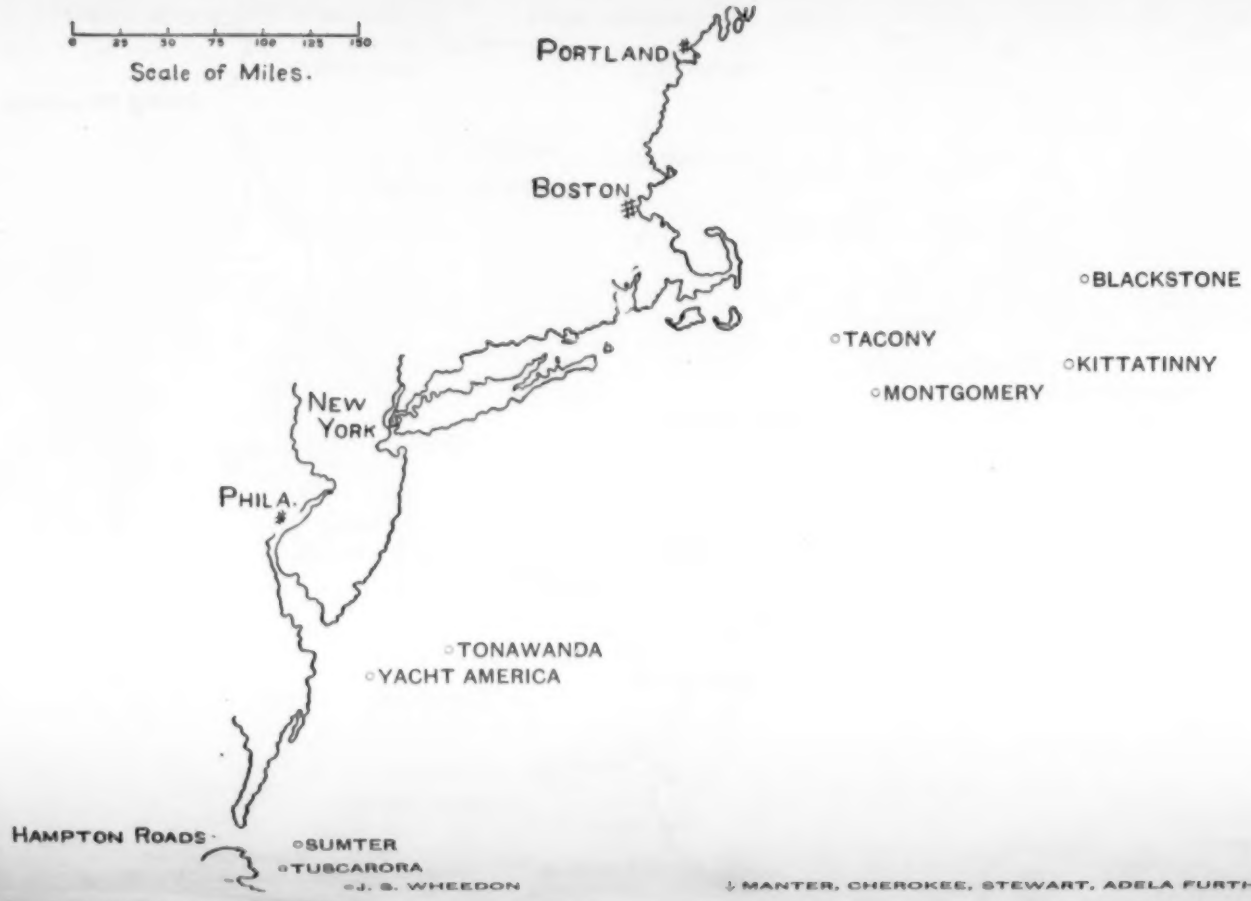
June 18.
0 25 50 75 100 125 150
Scale of Miles.
PORTLAND
BOSTON
SARAH BURTON
YOUNG TURK
HERBERT MANTER
AMY
NEW YORK
KATE STEWART
MONTGOMERY
J. S. WHEEDON
CHEROKEE
KITTATINNY
PHILA.
MARION
BLACKSTONE
TACONY
TONAWANDA
YACHT AMERICA
SABINE
ADELA
SEMINOLE
SUWANEE
HAMPTON ROADS
DAI CLING
COM. JONES
SUMTER
TUG AMERICA
YOUNG ROVER
TUSCARORA
VIRGINIA
June 19.

COM. JONES
SUMTER
TUG AMERICA
YOUNG ROVER
TUSCARORA
VIRGINIA
June 19.
Scale of Miles.
PORTLAND
BOSTON
BLACKSTONE
SARAH BURTON
UNITED STATES
KITTATINNY
NEW YORK
HERBERT MANTER
TACONY
MARION
KATE STEWART
PHILA.
J. S. WHEEDON
AMY
CAMBRIA
SUWANEE
TONAWANDA
YACHT AMERICA
SABINE
SEMINOLE
ADELA
HAMPTON ROADS
DAICLING
SUMTER
TUSCARORA AND VIRGINIA FURTHER SOUTH

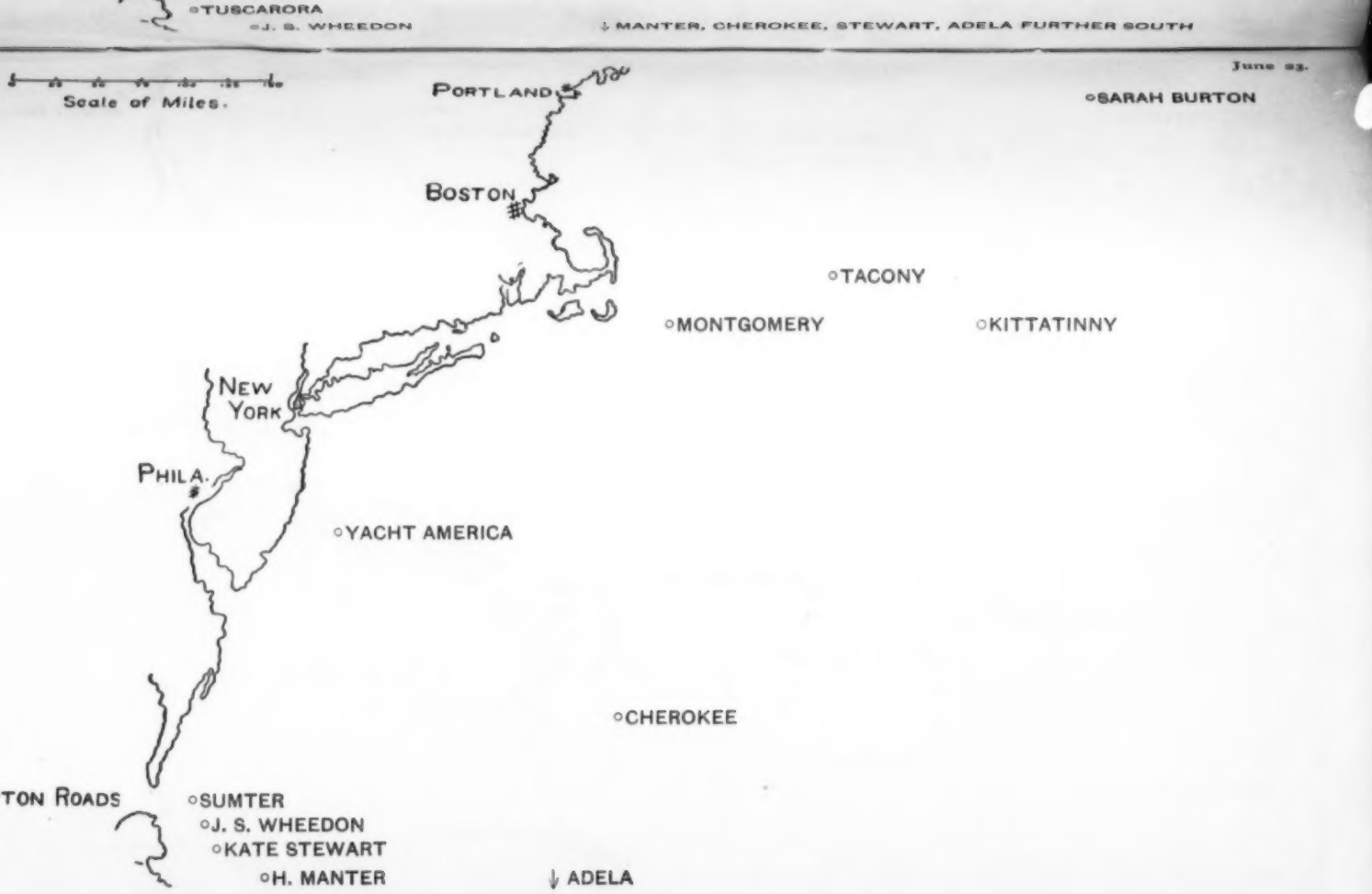

June 20.
0 25 50 75 100 125 150
Scale of Miles.
PORTLAND
SARAH BURTON
BOSTON
UNITED STATES
TACONY
KITTATINNY
NEW YORK
MARION
MONTGOMERY
PHILA.
CHEROKEE
HERBERT MANTER
KATE STEWART
SEMINOLE
YACHT AMERICA
HAMPTON ROADS
SUMTER
J. S. WHEEDON
ADELA
YOUNG ROVER
TONAWANDA
SUWANEE
CAMBRIA
TUSCARORA
VIRGINIA FARTHER SOUTH
SABINE
June 21.

YOUNG ROVER · TONAWANDA · SUWANEE · CAMBRIA · TUSCARORA · VIRGINIA FARTHER SOUTH · SABINE

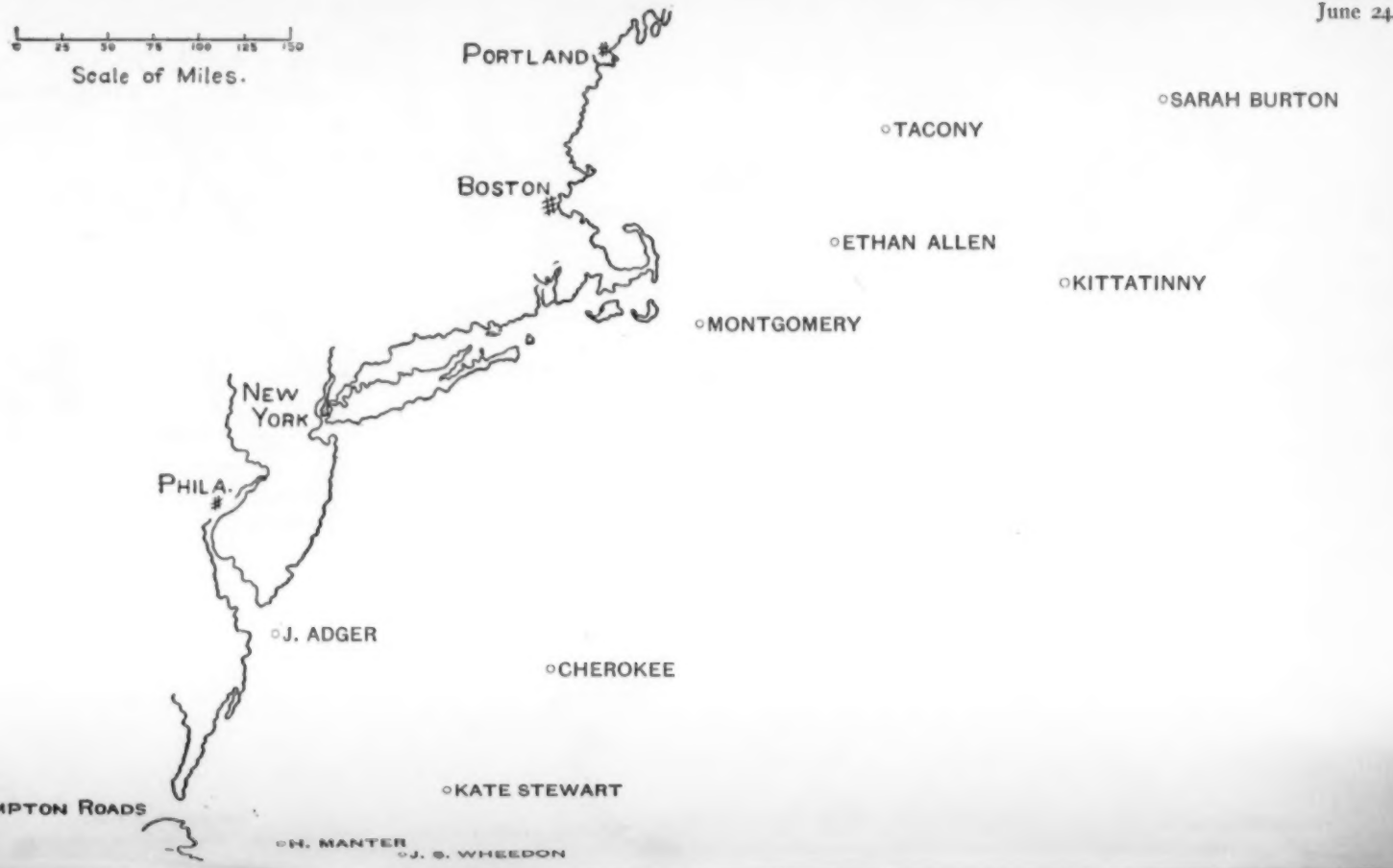
June 22.

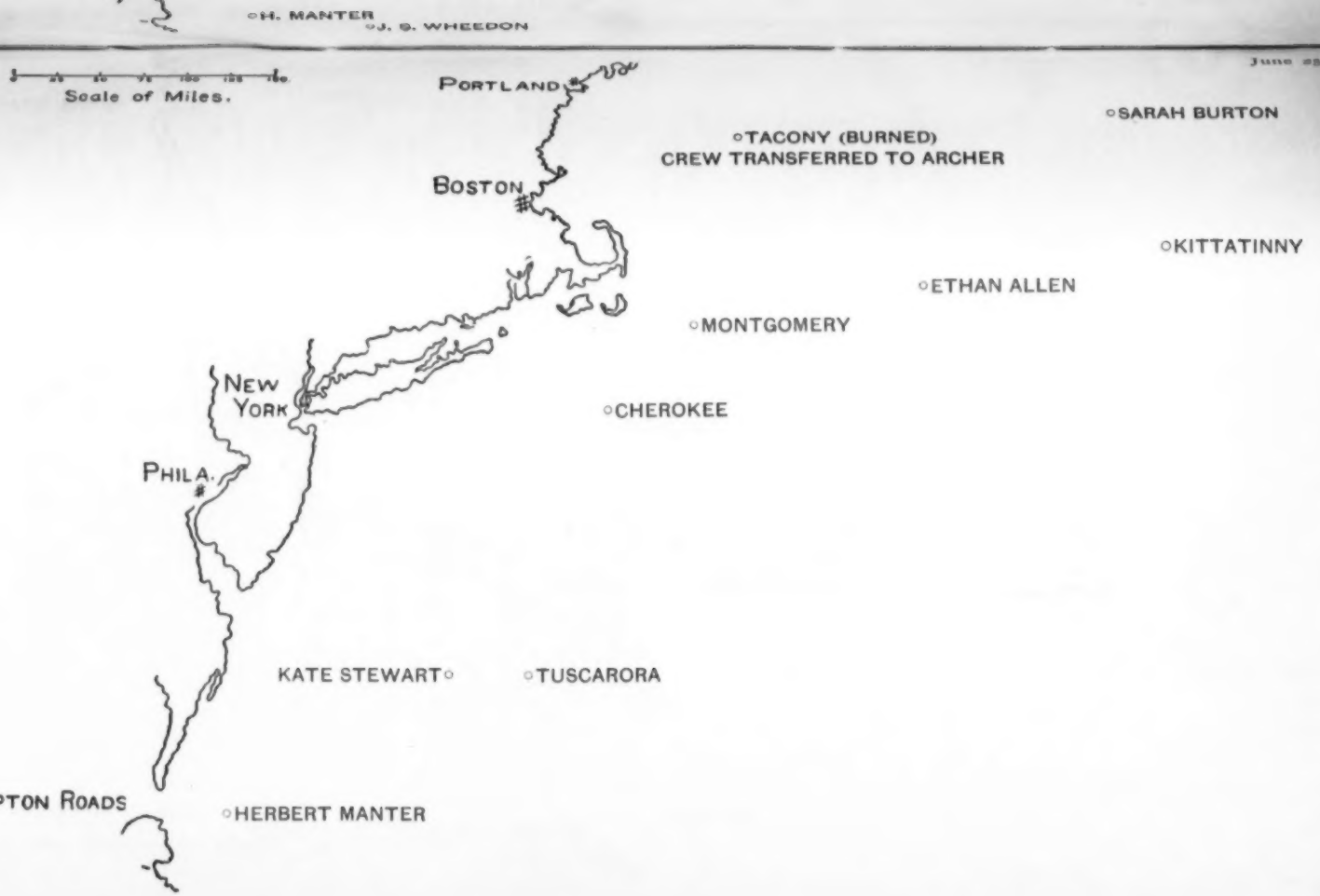


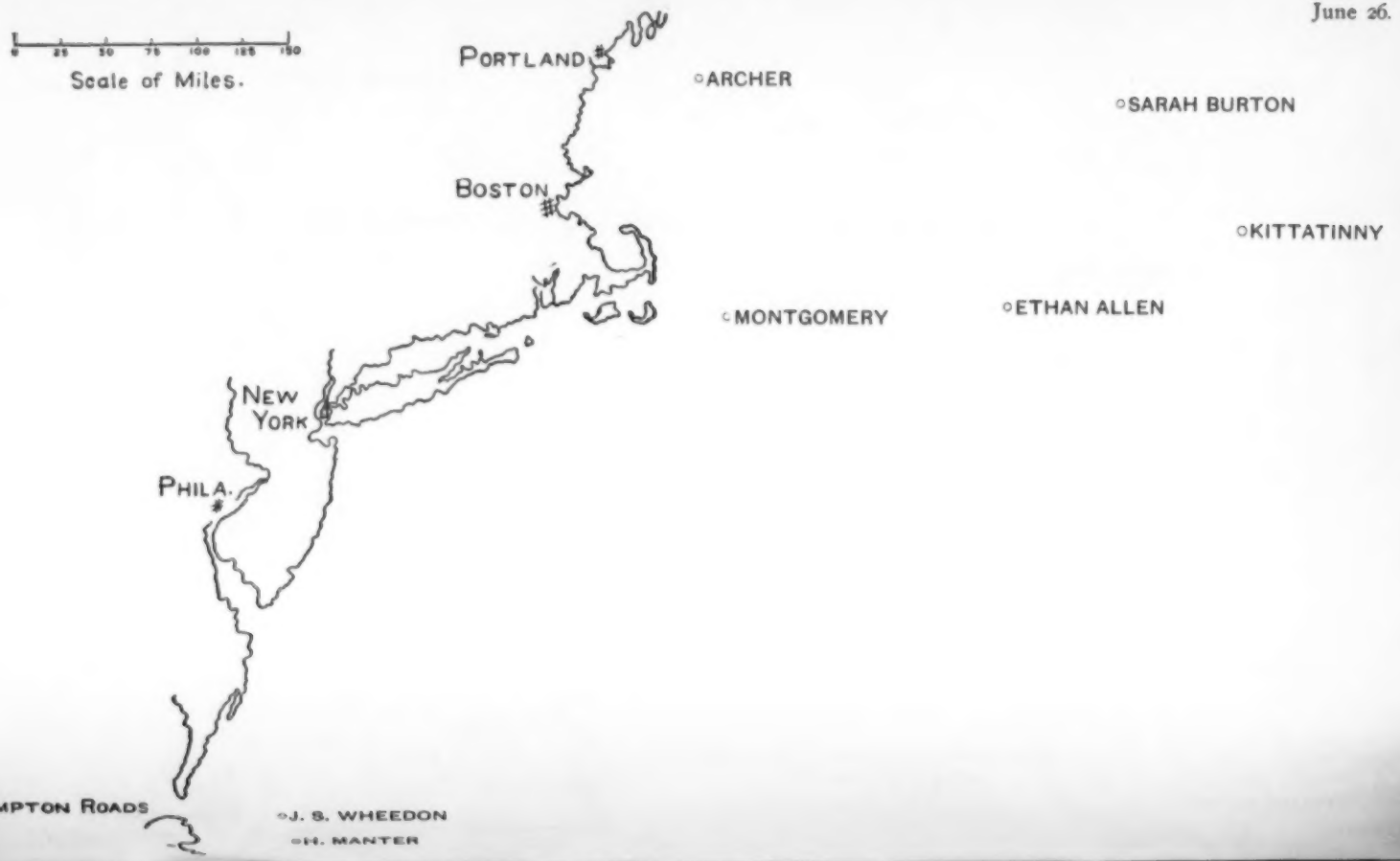
June 23.


TUSCARORA
J. S. WHEEDON
MANTER, CHEROKEE, STEWART, ADELA FURTHER SOUTH
June 23.
Scale of Miles.
PORTLAND
SARAH BURTON
BOSTON
TACONY
MONTGOMERY
KITTATINNY
NEW YORK
PHILA.
YACHT AMERICA
CHEROKEE
HAMPTON ROADS
SUMTER
J. S. WHEEDON
KATE STEWART
H. MANTER
ADELA

June 24.


0 25 50 75 100 125 150
Scale of Miles.
PORTLAND
SARAH BURTON
TACONY
BOSTON
ETHAN ALLEN
KITTATINNY
MONTGOMERY
NEW YORK
PHILA.
J. ADGER
CHEROKEE
KATE STEWART
HAMPTON ROADS
H. MANTER
J. S. WHEEDON


H. MANTER
J. S. WHEEDON
Scale of Miles.
PORTLAND
SARAH BURTON
TACONY (BURNED)
CREW TRANSFERRED TO ARCHER
BOSTON
KITTATINNY
ETHAN ALLEN
MONTGOMERY
NEW YORK
CHEROKEE
PHILA.
KATE STEWART
TUSCARORA
HAMPTON ROADS
HERBERT MANTER


Scale of Miles.
PORTLAND
ARCHER
SARAH BURTON
BOSTON
KITTATINNY
MONTGOMERY
ETHAN ALLEN
NEW YORK
PHILA.
HAMPTON ROADS
J. S. WHEEDON
H. MANTER

PROFESSIONAL NOTES.

TORPEDOES IN OUR WAR.

The electric torpedo system originated in America, so says Captain Davidson, formerly of the Confederate Navy.

After frequently referring to torpedo operations, in his "Naval History of the Civil War," in varying terms of censure or of praise, Admiral Porter finally disposed of the whole question as to the efficiency and propriety of that method of warfare in the most complimentary terms of approval. But nowhere did he make the important distinction that there were two defensive methods or systems practiced during the war—the one electric, especially designed and perfected in every detail, and completely under the control of those operating it; the other a system (if it can be so called) of guerrilla torpedo warfare, which succeeded in destroying many vessels in the West, but closed all channels to friend as well as foe, and was too unreliable to be adopted as a regular service.

The distinction is important, and it is a matter of historical interest to know that the electric system of torpedo defense, now adopted by nearly every maritime nation, originated in the States during our war, and that the guerrilla method is never taken into consideration as a means of warfare, although it may be again resorted to in exceptional cases.

Admiral Porter states, in effect, in the work just referred to, that the floating torpedo which destroyed the Cairo was fired by a galvanic battery on the 12th of December, 1862. In this I am quite sure he is mistaken. No report was ever made to the government at Richmond of the successful use of electric torpedoes during the war, previous to my destruction of the Commodore Jones in May, 1864. Persons were, doubtless, experimenting with galvanic batteries in the West, but the torpedoes used against Admiral Porter' fleet were known as contact torpedoes, of which there were many different kinds, and great ingenuity, mechanical skill, and self-sacrifice were shown in their design and application.

The importance of knowing exactly when and where electric torpedo defense was first proved to be a success in the war is generally admitted. Many have written upon this subject since the war, but from want of full information have made great confusion, and somewhat deprived our countrymen of the credit due in the matter, for I have frequently heard abroad that the practice originated with Russia.

Most persons interested in navy and army matters are more or less acquainted with the history of electric torpedoes; that is, of the many attempts made in the last and this century to use them successfully in war; and that every attempt met with failure until the Civil War in the States. With the reasons for those failures I am not now concerned,

but I desire to draw attention to the impression upon the public mind which those failures made: an impression not only of indifference, but rather of contempt for that means of warfare; so that the reader of history may understand that the great difficulty the officers of the South had to contend with in their efforts to make electric torpedoes successful did not lie so much in devising or designing new, untried methods, as in the treatment, or rather discouragement, they met with from friend and foe for giving their time and expending the resources of the country for such a service by the one, or the "uncivilized" character of the means by the other.

In the fall of 1862 I received confidential instructions from the Secretary of the Confederate Navy to organize a torpedo department for defense and offense—under his direct authority—to form a corps of officers and men, purchase material, supplies, etc., and proceed to make experiments so as to get into active service as soon as possible.

All know how limited were the resources of the South, especially in such skilled labor and extraordinary material as a torpedo service required. However, by the spring of 1863 I had fully complied with the orders of the Secretary, and the Electrical Torpedo Department, as organized and commanded by me, was the only one of the kind under the authority of the Confederate Government, and during the latter part of the war it was extended to include the whole South.

It was a complete organization in every essential part, having a body of officers and men carefully selected for their character and intelligence, with relative rank and duties assigned them.

The mines and their attachments were carefully designed and made at the Tredegar Works at Richmond, according to detailed drawings and specifications furnished by me. Expensive and laborious experiments were made to determine the effect of gunpowder at different depths of water. The galvanic batteries were designed so as to be efficient, portable and quickly brought into service, to accomplish which was the greatest practical difficulty met with, for, when I took charge, the means of explosion known to us then were entirely too crude and clumsy to be of practical use. The insulated wire had to be procured from the North or from Europe, at great trouble and expense, through the blockade. Storehouses were built at suitable places for torpedo supplies, and a store vessel was anchored in the James river, with provisions and clothing, in charge of a paymaster. Finally, the torpedo stations were connected by telegraph with the office of the Secretary of the Navy, Mr. S. R. Mallory, formerly Senator from Florida.

If I am not carried away by what I deem to be the importance of this organization, I may assert that its success (as will be seen further on) marks as distinct a period in history as the battle of the Merrimac and Monitor, or the employment of rifled ordnance.

The result of the organization, as just described, was the complete destruction of the gunboat Commodore Jones in the James river, May, 1864, by a torpedo mine made at the Tredegar Works, containing 1,800 pounds of sporting powder, placed in six fathoms of water and fired under my immediate direction. The destruction was effected at midday, and when the gunboat was accompanied by a powerful fleet under Admiral S. P. Lee. The fleet had on board a late servant of mine—a negro boy—who warned the officers that they were on dangerous ground. I was aware that the negro had deserted in the direction of the fleet, and for that reason had wires leading to the batteries on both sides of the

river, believing that if the fleet cut the wires on the high left bank they would be content with that and proceed, not supposing that there was a battery with mines on the other side also, which was a swamp.

My surmise was somewhat correct, for, had the battery station on the left bank been occupied, we should have been discovered, as at one time the Commodore Jones was high enough up stream to have seen into the station; she could have been destroyed moments sooner, but we were waiting for an ironclad. The orders given on board were distinctly heard by us, and it was in consequence of certain orders that the Commodore Jones was destroyed as she dropped back and over the mine.

The fleet very soon after (the same afternoon) retreated down stream, and did not return so high up the river again for more than a week, the importance of which will be seen further on. Many valuable articles from the wreck were picked up, especially official correspondence of importance to the Confederate government. The Captain's trunk, private correspondence, Bible, etc., were carefully packed up and sent at once to Major Mulford, of the United States flag-of-truce steamer.

The simple act of destroying the Commodore Jones was not in itself of so much importance as the destruction by torpedoes of many other vessels—ironclads, for example; but aside from its marking the first success of an electric system of torpedoes, it had another bearing.

On May 5, 1864, General Butler landed at Bermuda Hundred, guarded by the same fleet, under Admiral Lee, to which the Commodore Jones was attached. Admiral Lee lost no time in pushing on up the river with his whole fleet, for in a few days thereafter he was off Four Mile creek, where he witnessed the destruction of the Commodore Jones. On the 16th of the same month General Butler made his attack at the rear of Drury's Bluff, James river, and was repulsed by General Beauregard. That struggle was one of the hardest of the war. The trees and ground in front of the works were a sight to behold. There was many a moment when the result was doubtful.

Now, the object of pushing Admiral Lee's fleet, accompanied by transports, up the river at that time was believed in Richmond to be the assistance of General Butler in the attack on Drury's Bluff. Certain it is that there was nothing to prevent Admiral Lee from doing so but the torpedo defenses, and these, as already shown, compelled his retreat for the time. (Chapin's Bluff batteries were just below Drury's Bluff, but they would not have prevented the monitors from attacking both bluffs.) This was, of course, known at Drury's Bluff, and enabled several hundred of our best gunners to leave the batteries in front and serve the guns in the rear works against Butler.

If Admiral Lee could have sent a few ironclads to within sight of the Bluffs, the gunners stationed at the river batteries would have been retained here. Without them at the rear, General Butler could not have been repulsed, and Drury's Bluff, the key to Richmond, would have fallen that 16th of May, 1864.

Mr. Mallory, the Secretary of the Navy, in writing me after the war, uses these words: "The destruction of the Commodore Jones, the leading vessel of Admiral Lee's fleet, which was ascending the James river to co-operate with General Butler in the attack on Drury's Bluff, by causing the retirement of that fleet, undoubtedly saved Drury's Bluff, the key of Richmond." And in the same letter he adds: "I always

regarded the submarine department under your command as equal in importance to any division of the army."

Admiral Porter states that the man who fired the torpedo that destroyed the Commodore Jones was shot from one of Admiral Lee's boats. This is a mistake. He was still living in 1889. The man shot was a carpenter of no torpedo importance. He also says that the men captured were "very communicative." I am sure Admiral Lee thought they were, and that was just what I wanted. They were as good and true men as ever stepped in shoe leather, and had often been well drilled as to how much and what to say, in case of capture, for we were always much exposed. Had they been untrue, the fleet could have captured me, and also destroyed the backbone of the James river, the torpedo defenses, that same afternoon, and gone on up to the assistance of Butler at Drury's Bluff and, I believe, to the capture of Richmond.

I have often thought there was as much to be accomplished in working upon the credulity of the opposing force in time of war as in the use of your weapons, and that a special department might reasonably be organized for that purpose. This suggested itself to me during our war, because my torpedo department could not then be assisted by gun batteries at the several torpedo stations, and I was forced to all sorts of stratagems in order to work the defenses without such assistance. Think what might have been done with a highly nervous man like General Bragg, or even Sherman, for that matter, he himself having said, as we read: "The difference between Grant and me is, Grant don't care a d—n what the enemy is doing, and it just runs me crazy."

The personnel of war is not made up of Lees or Grants, but of comparatively very inferior substances, and the larger number of high officers could be easily thrown off their guard and made to vacillate, delay, and sacrifice their opportunities by annoying devices, plans, demonstrations, etc., well arranged and put forward by some such genius as would make a first-class detective, for instance. Of course, both sides could play at the same game; but as in the case of the torpedoes, the side that did not use it would be under a disadvantage.

A narrow escape was made by General Foster, General Negley, Lieutenant-Commander Cushing, and others when making a reconnoissance up the James river (I think in August, 1863), accompanied by the Monitor and another vessel. The Commodore Barney was ahead, and just above Atkin's Landing, when an electric torpedo of 1,800 pounds powder in five fathoms of water was prematurely exploded under her bows; but her headway took her under the falling mass of mud and water, and many men and much material were washed ashore. The Northern papers stated there were thirty-six men killed and wounded. The officer in charge of the torpedo station had the "buck fever," and fired the torpedo from sheer nervousness, and when I arrived at the station, half naked, from a bed of illness, he could hardly speak.

That was the lowest station on the river at that time. I was almost always near by, but on that day I was ill in bed with bilious fever, and rode to the station en déshabille, hoping to arrive in time. It was Cushing's sudden dash up the river that saved the situation. I should certainly have let the Commodore Barney pass on up and waited for the Monitor, knowing that at least the Barney could have been destroyed on her return. It is very singular that this occurrence did not give sufficient warning to Admiral Lee to enable him to avoid the destruction

of the Commodore Jones, and carry out the object of his expedition in May, 1864, when co-operating with General Butler in the attack on Drury's Bluff on the same river.

The failure to destroy the Barney made a most unfavorable impression at Richmond, and increased the howl of my opponents against the service I was engaged in, but I was always firmly supported by Mr. Mallory, who had the greatest confidence in the success of that means of warfare, and by our mutual friend, Captain John M. Brooke, who, later on, became Chief of Ordnance, and then the Torpedo Department feared no enemy in the rear.

In Admiral Porter's remarks as to the attack on the Minnesota, he says that "no serious damage had been done," and "the torpedo, which weighed fifty pounds, was not placed in contact with the ship, but was prematurely exploded." These statements are incorrect. There was a board of inspection ordered on the ship, and it reported much damage—certainly enough to justify the assertion that the torpedo was not "prematurely exploded," if we have no other evidence; but the contact was as well made as it is possible with any ramming torpedo known, even at the present time.

The report of the inspecting board, or of the commander of the ship, I forget which, showed that the torpedo exploded just abreast of a mass of shot and shell that the Minnesota had lately taken in to carry South. Moreover, the torpedo was too small—I thought so at the time. I could not get a larger steamer suitable for the purpose, and the one I used would not manœuvre with a larger torpedo down in an ordinary sea-way in such open waters as the mouth of the James river.

The attack, however, may fairly be called a successful one. It was the only attack of the kind during the war where any success was met with without the loss of the attacking party, and consequently the only one to prove the efficiency of the method. It must be considered that I had to explode my torpedo against perpendicular sides, whereas Lieutenant Cushing was lucky enough to find a vessel having an "overhang" (the Albemarle) under which he could not help getting his torpedo. He didn't require a contact with the sides.

As to being drawn into the hole in case I made one in the side of the Minnesota (as was the case with the David that sank with the Housatonic), I had provided for that by previous practice by direct ramming at an angle, always stopping the engine before striking, and practicing the engineer to go full speed astern as soon as he felt the blow, without waiting for orders. My torpedo struck the side of the Minnesota and exploded in just about one second after contact—an excellent result for the fuse of that day. The pole was shattered to pieces and the little steamer driven back forcibly.

When she backed off about fifty yards, and stopped to reverse and go ahead, her single cylinder engine caught "on the center," and there we remained—it seemed to me about forty years—under the fire of the Minnesota. The engineer, Mr. Wright (one of the bravest and coolest men I ever knew), got the engine free again, having to feel for the different parts in the dark. The little steamer was peppered all over with bullets. Several passed through my clothes, but we got off without any injury whatever. I then steered in the direction of Norfolk to throw pursuers off the scent, which proved successful. There was a steamer under the stern of the Minnesota that ought to have caught us easily. Several men were seen on her deck, forward, and those were fired at

rapidly to prevent their casting off their line, and she did not leave the Minnesota while in sight.

I believe there are those still living who, during the Civil War, regarded torpedo warfare as unworthy the higher qualities and duties of a naval officer. To such I would only ask: Whose judgment and foresight have proved the soundest? To those who believed it unfair and illegitimate I invite a careful study of all the circumstances attending the explosion of General Grant's mine before Petersburg, as compared with those under which the Commodore Jones was destroyed. Before making up my mind during our war to devote all my energies to the development of torpedo warfare, I thought seriously of the humanitarian phase of the question, but it did not take long to come to the conclusion that what we call humanity in war commenced after the surrender, excepting for the disabled, of course. Grant didn't think much of humanity when he used the mine at Petersburg, nor when he refused to exchange prisoners, knowing that the South was wholly unable to feed even his captured men; and to-day I believe that the more destructive weapons employed in wars, the less apt are wars to occur, and the soonest over. Long wars spread desolation and darken the earth. It would be far better to blow a whole army up in one mine and a fleet with another than that a war should last four years.

HUNTER DAVIDSON.

The Highflyer, a protected steel cruiser of the second class, was launched on Saturday, the 4th inst., from the yard of the Fairfield Shipbuilding and Engineering Company, Limited, Govan. The vessel is a sister ship to the Hermes, launched by the same builders on April 7, and illustrated and described on pages 470 and 497 *ante*. The two cruisers represent an improvement on the Juno class, of which the Fairfield Company built two—the Venus and the Diana. The dimensions of the Highflyer are: Length between perpendiculars, 350 ft.; breadth extreme, 54 ft.; displacement, 5,600 tons. The coal capacity is normally 550 tons, but provision has been made for carrying a greater quantity if necessary. The propelling machinery will consist of two sets of triple-expansion engines fitted in separate engine-rooms, each set having four inverted cylinders and four cranks. Belleville boilers will be fitted by the builders, and it is expected that the vessel will attain a speed of 20 knots.—*Engineering*.

The Angler, torpedo-boat destroyer, left Chatham Dockyard on the 3rd inst., for the final trials of her machinery, and the results obtained were satisfactory. The mean speed obtained for six runs on the measured mile was 30.559 knots. The official results were as follow for the three hours' full-speed trial: Draught of water, forward 5 ft. 11½ in., aft, 7 ft.; mean speed of ship, 30.372 knots; steam pressure in boilers, 212 lb. per square inch; revolutions per minute, 399.4 starboard, 398.3 port; mean indicated horse-power, 2,910 starboard, 2,910 port—total for the two sets, 5,820. The steering circle, stopping, and starting trials were also successfully carried out. The builders were Messrs. J. I. Thornycroft and Co.—*Engineering*.

REPORT OF TRIAL OF MARSDEN'S CORN-PITH CELLULOSE.

H. M. S. NETTLE, PORTSMOUTH.

Carried out on 18th January, 1898.

COFFERDAM.

The cofferdam was built of 15-lb. steel plating, 6 feet 6 inches high and wide, by 3 feet 3 inches deep. Its general scantlings are shown in the appended tracing. It was divided into three compartments by two transverse bulkheads. All rivet work was water-tight and the structure was well built. The middle compartment contained 67.58 cubic feet, the side compartments 35.52 cubic feet each.

THE CELLULOSE.

The cellulose was received at Portsmouth Dockyard on January 8, and was kept stored until the day of packing in the cofferdam, January 12. Its condition on opening the boxes was dry and excellent.

PACKING.

The middle compartment of the cofferdam was packed with 495 lbs. of cellulose in briquettes, at a density of 7.3 lbs. per cubic foot. The right-hand compartment was packed with 260 lbs. of cellulose, also in briquettes, at a density of 7.3 lbs. per cubic foot. The left-hand compartment was filled with 190 lbs. of cellulose, in the loose or natural condition, and condensed to a density of 5.35 lbs. per cubic foot. A plate cover with water-tight joints was then bolted on, and the cofferdam was set on board the Nettle for ballistic and obturation tests.

THE FIRING TRIAL.

The gun used was a 5-inch B. L. R., with the muzzle thirty feet from the face of the cofferdam. The projectile was a service common shell, weighing 50 pounds, with about 3½ lbs. bursting charge and nose percussion fuse. The striking velocity was about 1,200 feet per second. The shell struck the cofferdam on the central line two feet from the bottom and burst in the dam just as its joint entered the back plate. The explosion was very violent and blew out the entire back of the compartment, carrying with it about one-third of the cellulose in the rear of the cofferdam, but leaving the forward two-thirds standing quite firmly in place (as shown on the tracings). The rents in the plating extended into the side compartments, but the cellulose therein was not disturbed. The cellulose blown out was scattered all over the deck, but although the shell exploded inside the dam, none of the cellulose was set on fire or even charred. As soon as the photographs were taken, a box-shaped front of steel plating was bolted on the face of the cofferdam and a stand-pipe about three feet long was fitted on its top. An ordinary fire-hose was connected to a pump, and the front filled with water. The water at once rose to the level of the shot holes, but the cellulose began to expand and no water appeared at the back. The tank was filled to the top of the stand-pipe, but still the back of the cellulose, even under this pressure of a head of 7 feet 6 inches, was not even damp. Finally,

after seventeen minutes from the time the water was put on, a hole about eight inches in diameter was washed out directly in line with the shot-hole. The rest of the material still remained firmly in a ring or arch around this opening. Experiments were then discontinued and the cofferdam slewed around with handspikes to get another photograph. Even this shaking did not dislodge the arches of briquettes.

This completed the firing trials. It is interesting to note that a head of water three feet above the head of the cofferdam (the height of which was 6 feet 4 inches) gives a mean head of 6 feet 2 inches on the cellulose. As the total exposed area of the compartment was 20.8 square feet, the total pressure withstood by the unsupported cellulose was about 3 lbs. by 144 by 20.8, 8,985 lbs., which is four tons. When it is considered that this weight was borne for four minutes solely by the expansive power of the cellulose, against the walls of the dam, the result appears most remarkable and highly satisfactory in every way.

THE BOILERS AND BULKHEAD DOORS OF THE CHICAGO.

The unarmored cruiser Chicago of the United States navy was one of the original vessels of the famous "White Squadron." She was launched in 1884, and on her trial trip she made 15 knots with 5,083 horse-power. It was decided about three years ago to make many changes in the Chicago, and these changes, which are almost completed, will convert her into a fast cruiser of 18½ knots, developing about 9,000 indicated horse-power. New engines, of course, were required, and they were built at the Brooklyn Navy Yard, as well as the boilers shown in our engraving. The Bureau of Steam Engineering adopted a combination of the cylindrical Scotch boilers and the sectional type. The engine-room is next the four Scotch boilers, then comes the blower room, then the six Babcock & Wilcox boilers. The Chicago will be worked under forced draught on the closed stokehold system when running at high speed. Our engraving shows a pair of the Scotch boilers, which are about 1,000 horse-power each. They are placed athwartships, and our illustration supposes the visitor to be in the stokehold looking at one pair of boilers, while the other pair is at his back. The Scotch boilers all make use of a common stack, and at the level of the protective deck the stack is crossed by heavy armor bars which preserve the integrity of the protective deck.

The Scotch boilers were built at the Brooklyn Navy Yard and are made of nickel steel, the sheets being $1\frac{5}{16}$ inches thick and the heads ⅞ inch thick. The mean diameter is 13 feet 8½ inches and the length 10½ feet. The three corrugated furnaces are 3 feet 5 inches in diameter and are all fired from the same stokehold. The length of the grate is 6 feet 8 inches. The outside measurement of the 417 tubes is 2¼ inches, and they are of a thickness of No. 10 Birmingham wire gage. The heating surface of the tubes is 1,770 square feet; the heating surface of the furnace is 134 square feet; the heating surface of the combustion chamber 166 square feet, and of the tube sheets 66 square feet. The total heating surface is 2,138⅔ square feet. The grate surface is 68.33 square feet. The boilers are covered with magnesia covering. It is expected that the Scotch boilers will drive the ship at a speed

A pair of nickel steel Scotch bottoms for the steamer under Chinese.

of 13 nautical miles an hour, and with the water-tube boilers it is expected that 18½ nautical miles an hour will be made. The six Babcock & Wilcox boilers have a total heating surface of 18,000 square feet and 360 square feet of grate surface, making the total heating surfaces foot up 26,550 square feet and the grate surfaces 633 square feet. The bunker capacity is 920 tons. The steam pressure is 180 pounds per square inch.

The twin-screw engines are of the horizontal triple expansion type. The cylinders are 33½ inches, 50½ inches and 76 inches, the stroke is 40 inches and the engines make 120 revolutions per minute.

We now come to another interesting feature of the reconstructed vessels—the bulkhead doors. Lord Charles Beresford says: "It is a fact that upon the loyalty of the water-tight doors, when closed, and upon the assurance that they are properly closed, depends the power of a battleship to float when wounded by ram, torpedo or a gun. It has been authoritatively stated that the cause of the loss of the Victoria was that the water-tight doors were not closed, and it has been constantly proved to be impossible to close water-tight doors in an emergency, no matter how well disciplined and how gallant the ship's company may be. The system of closing the doors by evolution as to time invites an accident." Some very able experts contend that there should be no doors at all, and that the main bulkhead should be intact to the main deck.

To the layman, the number of bulkheads, doors, hatches and valves is extraordinary. Take the battleships Indiana, Massachusetts, or Oregon, for instance; they have 272 water-tight compartments, and the total number of water-tight doors and hatches is 354. The number of valves for ventilating, draining and flooding hulls, including sea-valves and pump-suctions, and excluding all valves for motive power and auxiliaries, numbers 294, making a grand total of water-tight doors, hatches and valves of 648. Valves are less important than doors and hatches, but when they guard a sluiceway, the passage of a ventilating pipe from one compartment to another, or a magazine flood-cock, they involve the integrity of the ship in an emergency. It is hardly possible to exaggerate the sudden turmoil and shock of a collision in a sea-way, accompanied by fog and blackness, perhaps within as well as without the ship, the wild upheaval and stampede of being torpedoed, or the strain and jar of modern battle; and it requires about 110 men, excluding officers, to bring the cellular structure of the ship into operation when needed in the type of ship to which we have referred, so there is no wonder that ships go down when they have their skin punctured below the waterline, as for instance the Vanguard, Victoria, Blanco Encalada, and Elbe.

Many experiments have been tried and systems introduced for the instantaneous closing of all the bulkhead doors in an emergency. We present some engravings of one of the most successful solutions of this problem—the "long arm system" of Mr. W. B. Cowles, of the Construction Department of the United States Navy. The cruiser Chicago as reconstructed is provided with an installation of this system. Mr. Cowles considered that a practically perfect system would be to tie together in assorted bunches the widely-distributed devices in a ship, by bringing the connecting strings from each device to a switch-board for each bunch and then assemble the switch-boards into one or more central stations, from which each device can be controlled by an operator, independently, and to arrange the devices as they are needed to

be operated in case of an emergency, so that this can be done with precision and full knowledge, from a point where the emergency can first be discovered. Arrangements should also be provided so that neither the emergency operation nor any other can harm the attendant or take control out of his hands, and all water-tight doors should be given an equal rank and precedence with the bulkhead of which when closed they form an integral part. The water-tight doors should be capable of closing under head or rush of water, and every bunker door should be able to close through coal. A system of this kind, placing its sole manipulation in the hands of one man, is comparable to the switch and signal tower of a railway.

There are two general schemes in the Cowles long arm system—the double line and the single line. The double line is more complicated and efficient, involving an operator at the central station. The single line

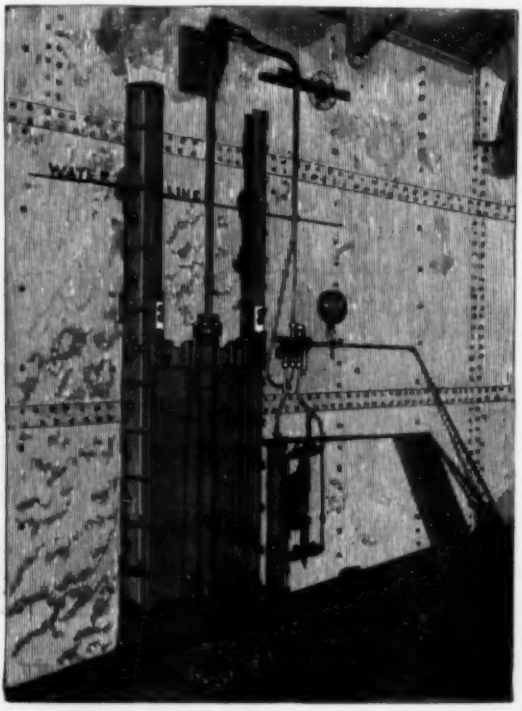
Bunker door with clear way open four inches.

answers in many cases where control valves and telltales are not required at the central station. Our illustration shows the single line system as applied on the United States cruiser Chicago.

The installation consists of eleven vertical sliding doors, all in the engine and boiler compartments, made of ¼-inch steel plates with vertical angle iron stiffeners and with manganese bronze plowshares to force its way through coal. The power cylinders for each door are made of seamless brass tubes. The system is operated by a steam accumulator and duplex pump of the Worthington type. They are placed under the protective deck. The hydraulic main is 2 inches in diameter, reduced in suitable steps. The emergency gear consists of a power cylinder with a 4-inch stroke, operating the by-pass cock on the accumulator and a corresponding telltale and controlling valve in the conning tower, con-

nected by a ⅛-inch pipe and forming a "primary circuit." This circuit consists of two cylinders with their pistons and piston-rods connected by a double line of small piping. One cylinder, called the power cylinder, is connected with the device to be operated; the other cylinder, called the "telltale," is placed at the point where it is intended to operate the device. These two cylinders may be at any distance apart.

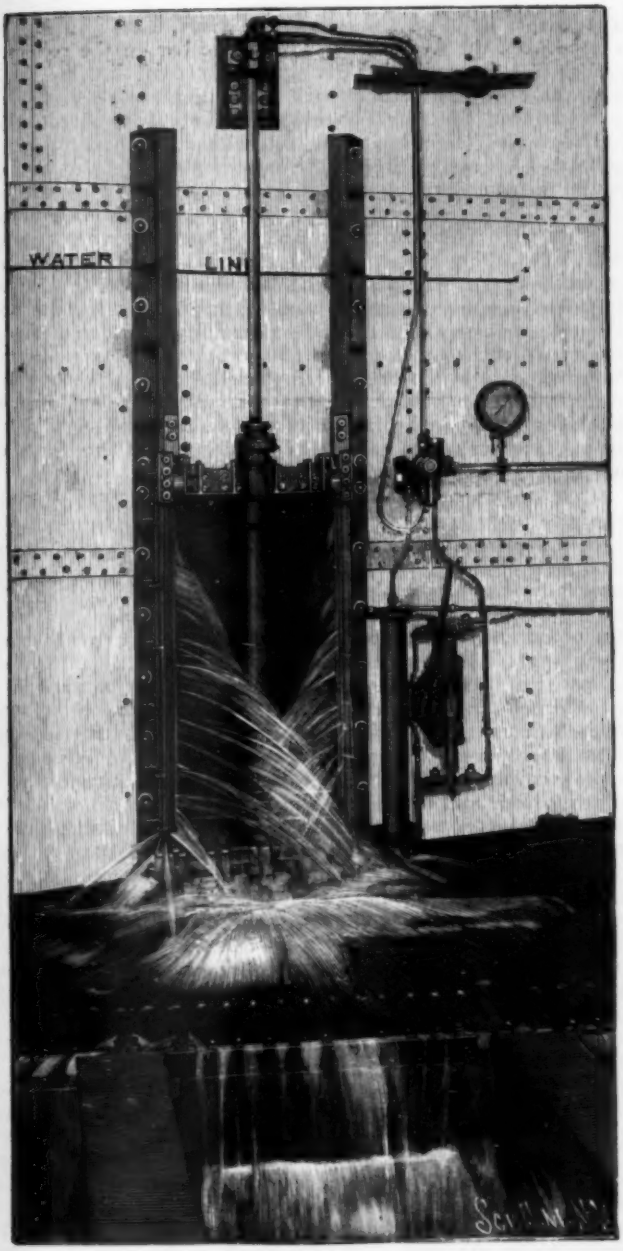
The double line of piping is so arranged that the pistons in the cylinders operate in exact accord. The power cylinder does the desired work, while the telltale cylinder reveals the position of the lower cylinder and consequently that of the bulkhead door. At each door is a so-



Bunker door under a head of water just before opening.

called "liberty valve," which can be started independently of the general system. Ingenious devices are provided to tighten the doors at side and bottom. One of our engravings shows the door under a head of water, with the tightening gear slacked up, and another, a bunker door, with all the tighteners in operation.

The side tighteners consist of traveling rollers held between a wedge track and a wedge bar, each of these latter being the full length of the door. The wedge track is secured permanently to the door, and the wedge bar rides with the door throughout its travel, except during the short tightening interval at the closing end of the stroke, within which



Bunker door under head of water, with tightening gear slacked up.

the wedge bar is held stationary on the guide, thus causing relative movement between the wedge track and wedge bar on the rollers. This movement presses the wedge bar out against the guide lip, and the wedge track, with the door and seating strip, in against the seat.

The doors are of ¼-inch steel plate with 2¼-inch by 2¼-inch by ⅜-inch vertical steel angle stiffeners at side and with manganese bronze plowshare and top tightener castings stiffening, respectively, the bottom and top edges of the plate; the seating strips at top and bottom are of steel ⅜ inch thick; the side seating strips, wedge tracks and wedge bars are of naval brass with Tobin bronze rollers 1½ inch diameter by 1½ inch long. The interlocking toes, pins and rollers are of steel, with adjustable manganese bronze stop-plates and fish-plate brackets. The wedges set in the plowshare are of steel, removable, and all parts of the door are screwed together throughout in such a manner that corrosion cannot affect the screws and so that any part may be renewed without injuring any other part. It should be noticed that the side edges of the door, outside of the stiffening angle, are flexible. When the tightening gear is free the door has ⅛ inch play in its guides, both side-tips of toes are easily ground and pressed down, and fall to the floor between the webs and seat.

ADDITIONS TO THE NAVY IN 1897.

The year now closing has been one of considerable activity in naval work, and although the tonnage and power of vessels actually floated falls short of that of some preceding years, the cause is easily explained, and is temporary. The engineering dispute has delayed the work in private yards, and also in the dockyards—two more battleships would have been floated had the stern frame and stem, etc., been machined and delivered in time, the under-water fittings completed, and the propeller-shaft tubes bored. But while the tonnage floated is not so great as in some previous years, there has been continued recognition of the need for sea power, and thus the Admiralty have been liberal with their orders and assiduous in seeing that the work is expeditiously done. We have already recorded the expansion of the original navy programme for the year; all the vessels have been ordered except four armored cruisers, which will probably be given out early in the year. Meanwhile we content ourselves with a consideration of the warships built and tried during the year.

There have been 45 warships constructed in 1897 for British and foreign powers, and these in fighting trim represent a value of 6,617,700*l.*; while in the previous year the total value was 10¾ million pounds. This decrease is largely due to only one battleship being floated, whereas in last year's total there were included six of great size, four for Britain and two for Japan. Thus the tonnage in 1897 was only 96,786, against 155,849 tons in 1896; and even the latter was not a record, as the total in 1892 was 161,596 tons, although the average for the first six years of the decade is not over 100,000. The collective horse-power of propelling machinery for all warships, however, does not show the same falling off, aggregating 331,050 indicated horse-power, against 377,981 indicated horse-power, due to the inclusion of a large number of torpedo-boat destroyers. As in the past year, one-third of the tonnage completed was for foreign governments, principally Spain, Japan, China, and the

South American republics. The totals just given are accounted for as follows:

——	Number.	Tons.	I. H. P.	Value of Ships Completed.
Dockyard	4	31,885	47,000	1,752,700
Private yards (H. M. S.)	22	34,111	163,400	2,385,000
" " (foreign)	19	30,790	120,650	2,480,000
	45	96,786	331,050	6,617,700

In the previous year the foreign tonnage was 47,364; the horse-power, 118,364 indicated; and the value, when completed, 3,059,000*l.*; so that there has only been a decrease in tonnage. This is explained when it is recalled that instead of battleships costing 65*l.* per ton, a greater number of destroyers of 200*l.* per ton are included in the list.

The work of the Royal Dockyards does not bulk so largely as it might have done: two battleships are almost ready for launching. These, if they had not been delayed by the strike, would have brought the total quite up to the average, which for the preceding seven years was about 50,000 tons, against 31,185 tons for this year; while the average output for the navy from private yards is about 39,000 tons, against 34,111 tons for this year. But when it is recalled that the Royal Dockyards are so largely for repair, and especially for recuperative work in war times, the output has not the same significance; the interesting point is that there are in process of construction, including all vessels ordered and not yet tried, warships aggregating 355,620 tons and 766,800 indicated horse-power; at the end of last year there were completing, and under construction, vessels of 284,660 tons and 625,500 indicated horse-power, so that apparently there is more work now; but the rapidity of construction at the Royal as well as private dockyards will soon make a material reduction in these totals. The problems of design involved in this great fleet can only be guessed at; but the mere figures themselves suggest the work undertaken by Sir W. H. White, K. C. B., the Director of Naval Construction, and by Sir John Durston, K. C. B., the Engineer-in-Chief. Of the vessels building, 20, of 145,295 tons, with engines of 218,000 indicated horse-power, are in course of construction at the Royal Dockyards, where some 22,000 or 23,000 men are employed. The difficulties of management are great, at a time when labor is more or less in open revolt throughout the country; and the fact that there has been no real indication of cessation of work is due to the efforts of the Director of Dockyards, Mr. James Williamson. We give in the appended table the number and tonnage of the ships built for the navy in each year of the current decade:

PRODUCTION OF BRITISH NAVY SHIPS, 1890-97.

Year.	Dockyard.		Private Yard.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.
1890	8	22,520	13	42,475	21	64,995
1891	8	68,100	10	39,150	18	107,250
1892	9	50,450	13	90,750	22	141,200
1893	9	32,400	5	1,910	14	34,310
1894	6	96,700	19	4,825	27	31,525
1895	8	70,350	28	66,412	36	136,762
1896	9	71,970	26	36,515	35	108,485
1897	4	31,885	22	34,111	26	65,996
Total.	63	374,375	136	316,148	199	690,523

The vessels built for the British navy have already been described in *Engineering*, and here it is only necessary to mention them. From the Portsmouth yard there was launched the Canopus,* an improved type of Renown, differing only from the Magnificent class in having Belleville boilers and a slightly thinner although specially hardened armor, which so reduce the displacement as to enable the vessel to pass through the Suez Canal and steam into some of the harbors in the East with limited depth of water. The Canopus is 390 ft. in length, of 74 ft. beam, and at 26 ft. draught displaces 12,950 tons. Her engines, being built by Messrs. Scott, of Greenock, are to develop 13,500 indicated horse-power with natural draught, giving a speed of 18¼ knots. She has the same armament as our best ships. The Andromeda, the next ship in point of size launched from the Dockyards, is a cruiser of 11,000 tons, built at Pembroke, and belonging to the Diadem or Niobe class.† Her engines of 16,500 indicated horse-power are by Messrs. Hawthorn, Leslie and Co. The first of the class, the Diadem, will proceed on her steam trials in January, and much interest is attached to them, as the Belleville boilers are fitted with economizers in the up-take. The feed passes through the pipes of the economizers before entering the main tubes, and experiments with separate boilers give promise of a much higher efficiency than with the ordinary Belleville boiler. The Diadem is the first ship with these improved boilers to be submitted for trial. The Vindictive is a fleet cruiser especially strengthened for ramming, and armed for a long, stern chase.‡ She was built and engined at Chatham, and belongs to the same class as the Arrogant, the result of whose trials are recorded in our table. The fourth ship on the Dockyard list is the Pomone, launched at Sheerness, and fitted with engines by Messrs. Penn, of Greenwich. The prototype of the class was the Pelorus, described in *Engineering*, vol. lxiii, page 385. Devonport has not launched any vessel, but good progress has been made with the battleship Ocean. The output in tonnage from each of the five Royal yards is given below:

—	1896		1897		Eight Years.		Average.
	No.	Tons.	No.	Tons.	No.	Tons.	Tons.
Portsmouth	3	26,300	1	12,950	13	121,635	15,204
Chatham	1	14,900	1	5,800	12	100,330	12,541
Pembroke	1	14,900	1	11,000	9	78,915	9,864
Devonport	2	11,600	—	—	16	52,500	6,562
Sheerness	2	4,270	1	2,135	13	20,995	2,624

It is scarcely necessary to enforce the point that a very large amount of the work of the Dockyards is in connection with the trials of new ships, and repairs and overhauls for re-commission, etc. The extensive fleet of the British navy involves a very heavy expenditure under this head; this year it has been greater than usual, owing to the Review, and to the fact that as new ships could not be completed in time to relieve the ships abroad, others had to be overhauled for the service. In this

*See *Engineering*, vol. lxii, page 152.

†See *Engineering*, vol. lxi, pages 776 and 831, vol. lxii, page 538, and vol. lxiii, pages 278 and 309.

‡See *Engineering*, vol. lxii, page 708.

OFFICIAL TRIALS OF BRITISH WAR SHIPS, JANUARY TO DECEMBER, 1897.

Name of Ship.	Type.	Shipbuilder.	Makers of Machinery.	Coal Consumption Trial, 30 Hours.			Natural Draught.		Full Power.	
				Indicated Horse-power.	Speed.	Coal per Indicated Horse-power per Hour.	Indicated Horse-power.	Speed.	Indicated Horse-power.	Speed.
					knots	lb.				
Jupiter	First-class battle-ship	Clydebank Comp'y	Clydebank Engineering and Shipbuilding Company (Thomson)	6,198	14.1	1.51	10,248	15.8	12,475	18.4
Mars	Ditto	Laird	Laird	6,039	14.4	1.93 (Coal small at times.)	10,209	15.96	12,483	17.7
Hannibal....	Ditto	Pembroke Docky'd	Harland and Wolff	6,124	14.6	1.78	10,357	16.3	12,138	17.6
Caesar.....	Ditto	Portsmouth Dockyard	Maudslay	6,309	14.8	1.93	10,638	16.7	12,653	18.7
Terrible	First-class cruiser	Clydebank Comp'y	J. and J. Thomson (Clydebank)	18,500	20.96	1.71	25,648	22.41		
Doris.....	Second-class cruiser	N. C. and A. Company	N. C. and A. Company (Vickers)	4,933	16.5	1.47	22,370 8,425*	19.1	9,878*	19.7
Isis.....	Ditto	London and Glasgow Company	London and Glasgow Company.	4,925	17.5	1.6	8,208	19.8	9,840	20.1
Arrogant... .	Ditto									
Illustrious ..	First-class battle-ship	Devonport Docky'd Chatham Dockyard	Earle's Company Penn	7,624 6,155	17.8 14.5	2.1 1.77	10,290	19.6		

*N. D. and F. D. trials in 1896. The above list is exclusive of torpedo-boat destroyers, tugs, shallow-draught steamers, and other small craft.

way several ships have been largely renewed, amongst the number being the Mercury, Porpoise, Arethusa, Mohawk, Leander, Barracouta, Swallow, Hotspur, Raleigh and several others.

The British ships built in the private yards do not call for special note. The Europa and Niobe built at Clydebank and Barrow, are of the same class as the Diadem already referred to; and the Pegasus and Pyramus built by Palmer, and the Perseus launched from the Earle Company's yard at Hull, are of the Pelorus type. The other vessels on the list are mostly torpedo-boat destroyers—the Fairfield Company having launched the Gypsy, Fairy, and Osprey; Palmer's Company, the Flying Fish, Fawn, and Flirt; Laird Brothers, the Panther, Seal, Wolf, and Express, the latter exceptional in being a 32-knot vessel, while all the others are 30-knot craft. From the Barrow works of Messrs. Vickers, Sons and Maxim there was also launched the Leopard; Messrs. Doxford launched the Violet and Sylvia; Messrs. Hawthorn, Leslie and Co., the Cheerful; while Messrs. Thornycroft also added to the number, which further includes a few gunboats. But after all, the chief interest in these destroyers is the result of their speed trials, and we are able to give a list which shows the power, speed, and coal consumption of all the boats of the class which have passed through official trials this year. This table scarcely calls for comment; but it will be seen that for 30 knots the power has varied from 6,606 to 5,654 indicated horse-power; but as a rule, 6,200 is about the average. The best speed got was with the Fairfield boat, 30.674 knots. Messrs. Palmer have been very successful with these craft, although the coal consumption seems higher than with some of the others. There is in this respect remarkable variation. Perhaps it may be well to state that Laird Brothers adopt the Normand type of boiler, Thornycroft and Fairfield the Thornycroft type, and Palmer the Reed type. These have all been illustrated in *Engineering*. It may here be remarked that the Clydebank Company have, during the year, passed through their trials several Spanish boats.*

We also give in tabular form the official results of the trials of other ships. The first four ships and the last on the list are alike as regards design—they belong to the Magnificent class of battleship. The cylinder dimensions, too, are the same, so that the coal consumption may be fairly compared, although it may be that the variations in the draught of the ship vitiate any true comparison of the speeds realized for the powers given. All these ships, like so many of their predecessors, have easily attained on trial the results anticipated in their design. The Terrible was, as is now world-wide known, fitted with Belleville boilers, as is also the Arrogant. These two are the only vessels on the list fitted with water-tube generators.

As to the foreign vessels, Sir W. G. Armstrong, Whitworth, and Co. launched the cruiser O'Higgins, of 8,500 tons and 16,000 indicated horse-power, for Chili; the Hai-Tien, of 4,500 tons and 17,900 indicated horse-power, for China (see page 751 *ante*); the Takasago, of 4,160 tons and 14,750 indicated horse-power, all remarkably fast steamers; and the two Norwegian battleships, Harald Haarfarge and Tordenskjold, of 3,500 tons and 4,500 indicated horse-power (page 62 and 419 *ante*). The Clydebank Company launched four torpedo-boat destroyers for the Spanish government, the first of which was illustrated in the first number

* See *Engineering*, vol. lxiii, page 12.

of this year. Messrs. Laird, of Birkenhead, completed a training-ship of 1,270 tons and 1,000 indicated horse-power, for the Argentine navy, and Messrs. Yarrow built several torpedo-boat craft, principally for South American republics.

OFFICIAL STEAM TRIALS DURING 1897 OF TORPEDO-BOAT DESTROYERS.

Ship.	Builder and Engines.	Description of Trial.	Indicated Horse-Power (Three Hours).	Speed (Three Hours).	Coal per Indicated Horse-Power per Hour (when measured).
Quail	Laird	Speed	6049*	30.104*	
Thrasher		"	6003†	30.031†	
Earnest		Coal con.	6266	30.047	2.41
"		Speed	5931	30.137	
Griffon		Coal con.	6268	30.019	2.53
"		Speed	6081	30.111	
Panther		Coal con.	6606	30.142	2.43
"		Speed	6488	30.138	
Fame	Thorny-croft.	Coal con.	5912	30.155	2.595
"		Speed	5852	30.168	
Foam		Coal con.	5846	30.093	2.205
"		Speed	5654	30.184	
Mallard		Coal con.	5746	30.201	2.08
"		Speed	5905	30.115	
Star	Palmer.	Coal con.	6197	30.103	2.64
Whiting		Coal con.	6254	30.167	2.76
"		Speed	6315	30.209	
Bat		Coal con.	6209	30.229	2.59
"		Speed	6199	30.129	
Crane		Coal con.	6428	30.138	
"		Speed	6267	30.347	
Chamois		Coal con.	6265	30.396	2.42
"		Speed	6339	30.221	
Osprey	Fairfield	Coal con.	6588	30.674	2.58
		Speed	6412	30.427	
Zebra	Thames Maudslay	Speed	4816‡	27.003‡	

*Consumption trial, December 11, 1896. †Consumption trial, December 14, 1896.
‡27-knot boat.

HIGH EXPLOSIVES AND MODERN WAR-VESSELS.

The old battleship Resistance has at last come to the end of her somewhat chequered career, and her 4-inch iron plates have recently been stripped off for service as targets on the excellent ground at Whale Island. She has been riddled with ordinary projectiles of every calibre, torn to pieces between decks by high-explosive shells, and sunk by torpedoes on more than one occasion, having been subsequently raised for further experimental practice upon her hull. A vast number of points have been conclusively settled during the course of the experiments

which have been made with her. The futility of ordinary light armor as a preventive to the penetration of the smallest armor-piercing projectiles, even when protected by a backing of several feet of teak or oak timber, has been plainly shown. The great destruction which would be effected upon the upper decks by the smashing of the superstructure and boats thereon in action, has also been illustrated by experiments with dummies; whilst the value of a thick stratum of coal in bunkers along the ship's side has been thoroughly tested; and, lastly, the awful havoc which would be wrought between decks by the bursting of shells filled with high explosives, has been exhibited with appalling distinctness.

The first of these important lessons has resulted in the substitution of carburized armor plates for ordinary steel shields to protect all the heavy and medium gun positions in recent war vessels; the second, in the covering over of the upper deck battery at the sides with plating for some distance, and the stretching across the open space thus left between of a stout steel wire netting to catch splinters; and the third, in greatly multiplying the number and increasing the size of the coal bunkers along the ship's sides, from the main deck down to the bilge. The fourth lesson, however, remains only as a terrible, incontrovertible fact, which cannot apparently be got over. It is to this fact that we allude now.

We would invite an inspection of the hull and between decks of the Resistance in order to emphasize the remarks which we are about to make. No very heavy gun has been employed in negotiating the destruction of the helpless hulk; but 9.2-inch projectiles have passed through her from side to side, just as though she was so much putty, and even 6-inch armor-piercing shot have traversed her from stem to stern; the wrought-iron armor plates being torn off, and the skin of the ship's side and bulkheads being swept away as though they consisted of brown paper. Then the between decks is a sight never to be forgotten—framing, splinter screens, partitions, and bulkheads have been rent into fragments by the bursting of the high explosive shells, whilst grim splashes of a yellow substance that has marked the places where shells have bursted outside the plating betoken the character of the explosive employed.

It is now an acknowledged axiom that high explosives will be employed in shells. Whether naval officers object to carry them on board ship or not, they will in future be the principal ingredient by which shells are filled for coast and siege purposes; and already the nature of high explosives to be used as a service bursting charge for high-angle howitzers in coast and siege batteries has been practically determined.

After exhaustive trials, all inventions in this direction, except wet gun-cotton and lyddite, have been discarded. A satisfactory high explosive has been defined as fulfilling the following conditions: It should be safe in manufacture, store and transport, and stable under service conditions. It should be of a convenient form for filling shell, and safe to manipulate in the process. It must be capable of standing the shock of discharge in high velocity guns, and must, on striking, detonate with violence and certainty, and without the aid of any dangerous fulminate. The explosive should be capable of having its sensitiveness increased or diminished as occasion may require, and a shell, when filled with it, should not detonate when hit by another shell. Of those high explosives experimented with, the two coming nearest to the standard are wet gun-cotton, which has been adopted by at least one

European power, and lyddite, which is used in our service. Wet gun-cotton will not detonate in a shell struck by another shell, and in this respect is more satisfactory than lyddite; but gun-cotton, to produce its best effect, must be compressed into discs to fit the interior of the shell, and the shell must therefore be made in two parts and screwed together—a source of weakness and possible danger. Dry cotton and a a fulminate are, moreover, required to detonate it. Hence lyddite, to which none of these objections apply, will probably be adopted as the high explosive of our service.

Such being the case, it is interesting to note the character and appearance of lyddite. Under the name of picric acid it has long been known. Picric acid is a nitro-substitution compound obtained by the action of nitric acid on a variety of substances; for example, indigo, silk, acaroid, resin, etc., but on the commercial scale the substance now generally acted on by the nitric acid is carbolic acid, and the equation of the process is simple, viz.:

Carbolic acid. Picric acid.

$$C_6H_6O+3HNO_3=HC_6H_2(NO_2)_3O+3H_2O.$$

Picric acid may, as written above, be regarded as a picrate of hydrogen, which latter element can be displaced by a metal to form an ordinary picrate—for instance, picrate of potassium, $KC_6H_2(NO_2)_3O$. It is a crystalline substance of a brilliant yellow color, and is intensely bitter to the taste. It burns with a very smoky flame. It is largely used as a dye, or constituent of dyes, and has not been usually considered as an explosive. Nor, indeed, does it usually behave like an explosive under ordinary circumstances, though under special conditions easily produced, it is capable of developing its now well-known formidable explosive properties. It may be burnt away in an unconfined state in considerable quantity without explosion, but the mere contact of certain metallic salts or oxides with picric acid in the presence of heat develops powerful explosives which are capable of acting as detonators to an indefinite amount of the acid, wet or dry, which is within reach of their detonative influence.

Lyddite has proved to be a fairly stable compound, and safe in manufacture, store and transport. High temperatures abroad, or in ships' magazines, do not affect its condition. When carefully packed into shells it does not "set back" like the nitro-glycerine in dynamite, on the shock of discharge, and so interfere with the "exploder," or create a condition of extreme danger, from the likelihood of a premature. Several accidents have occurred during the firing of shells charged with lyddite, from this last mentioned cause, viz., the projectile prematurely exploding in the bore of the gun. But in the majority of cases the causes of the disaster were traced to faults in the shell, and were not due to oversensitiveness of the lyddite. Shells to contain it are now made of the best forged steel, which minimizes the prospect of prematures. The action of a powder fuse will not detonate lyddite, hence an exploder containing a few ounces of a safe and stable explosive is employed. It is inserted in a hole drilled centrally in the charge. The actual nature of the exploder used by the War Department is kept secret, but many metallic oxides and nitrates will detonate when brought into contact with picric acid at a high temperature, and this fact has probably been taken advantage of by the chemical department.

Clearly, then, the high-explosive shell has a very marked future before

it, for artillery fire or active service; and, as foreign governments have gone even further than we have in the development of this terribly effective projectile—for one European navy, at least, has already introduced the melinite shell into its magazines on board ship—we must be prepared for attack with high-explosive shells in the next naval action, not only from shore batteries, but from the enemy's vessels.

This is a serious outlook. Take the cases of the Majestic, Powerful, or Diadem types. Probably the 6-inch Harveyized steel armor plates upon the 6-inch gun casemates of these vessels would break up or explode outside the majority of high-explosive shells with which they might be attacked, and the side and barbette armor would certainly be sufficient to effect this desirable end; but the whole of the upper deck battery would be at the mercy of a few high-explosive shells which would burst within it, either from contact with a 12-pounder mounting or any other cause, and the whole of the main deck space from stem to stern, except the eight closed casemates, including the entire series of officers' cabins, would be mere shambles in a quarter of an hour. If any one doubts the probability of this, let him go over the Resistance and judge for himself. She is an object-lesson the value of which cannot be controverted.

But, it may be asked, is there any remedy for such a condition of terrible insecurity as regards the officers and crews of our war-vessels in the future should the high-explosive shell do all that is expected of it? We believe that there is a partial remedy, but we fear not one that will commend itself in the eyes of our naval constructors. Looking at the Powerful or Diadem, the enormous freeboard given to these types cannot but excite observation. Is it excessive or not? That is the question. We cannot help thinking that, in running away from the evils of low freeboard, we have now run into the opposite extreme, if only the casemates can be adequately protected with armor against high-explosive shells, whilst vessels of so high a degree of freeboard are being built. We would cut them down in future and utilize the saving in weight of material thus released to provide a more extensive system of armor protection over the reduced surface of the ship's sides. As the Powerful and Diadem types are at present, they are merely huge targets, which will be the sport and pastime of an energetic enemy who may possess guns firing high-explosive shells; their only chance in action would be to at once crush their enemy with their own high explosives, or run away and trust to the diminishing perspective of their form as they disappear over the horizon for the chance of not being hit. As regards our battleships, it is difficult to suggest anything; but surely a milieu could be designed between the Nile and the Trafalgar, which possess almost perfect immunity from the chance of destruction between decks by high-explosive shells, and the Majestic, which has none whatever about the main deck. Here is food for reflection.—*Journal of the Royal United Service Institution.*

AMERICAN AND EUROPEAN ARMOR PLATE.

The following important paper on the relative qualities and efficiency of European and American armor plate for warships has recently been submitted to the United States Senate Committee an Naval Affairs, by Captain O'Neill, Chief of the Bureau of Ordnance of the Navy Department:

While the great German concern has manufactured armor for many years, that made by the so-called Krupp process, which has of late attracted attention, dates from the test of an 11.8 in. plate, at Meppen, on September 15, 1895. In order to arrive at any satisfactory conclusions as to the superiority of Krupp armor over that manufactured up to the present time in the United States, or as to their relative merits, it is necessary to make a comparison of the tests applied and the results attained in both cases.

First, it should be observed that the much-advertised Krupp plates and English plates supposed to have been treated by the Krupp process are purely experimental or special plates, and do not, as far as can be ascertained, represent service armor, though they may result in setting a standard for future manufacture. From published statements, the Krupp plate referred to showed unusually good ballistic qualities, having successfully withstood the impact of three 12-in. armor-piercing projectiles, having striking velocities of about 1,993 foot-seconds. This plate, according to the formula used for computing velocities necessary for the perforation of face-hardened plates, should have been perforated by a 712.6 lb. (12-in.) projectile, having a striking velocity of 1,829 foot-seconds, whereas it successfully resisted projectiles having 164 foot-seconds greater velocity. None of the three shots perforated the plate, but from the fact that the back bulge, due to the third impact, was 3 in. high and slightly cracked, it would appear that the limits of its resistance had been almost reached; its most notable feature was the absence of cracks. It is worthy of note that in the test referred to the projectiles used were of Krupp's own manufacture, and, while no doubt of good quality, it is impossible to make a direct comparison with projectiles or plates made in this country. A slight degree of inferiority on the part of the projectile enables a plate to make a remarkably good showing, and the fact that the plate was tested at Krupp's proving ground with his own projectiles is not as convincing as it might have been under other conditions; nevertheless the test and its results seem to have been accepted, and the plate is referred to as the champion thick experimental plate.

In the London *Times* of August 20, 1897, is a report on an 11$\frac{11}{16}$ in. plate made by Vickers, Sons and Co. (English), which was officially tested at Shoeburyness on August 19, 1897. It was attacked by three 12-in. Holtzer projectiles, weighing 714 lb., with 1,861, 1,868 and 1,860 foot-seconds velocity, which only penetrated 2$\frac{5}{8}$ in. The plate successfully withstood the attack without cracking, and made a record about equal to the Krupp plate. By calculation it should have been perforated by a velocity of 1,814 foot-seconds, whereas it was not perforated with a velocity of 51 foot-seconds greater. The plate was called a nickel Harveyed plate; but as Messrs. Vickers have adopted the Krupp process, and dwelt on its excellence for thick plates, it is extremely unlikely that for this important test a Harvey process plate was submitted. The English *Engineer*, referring to this test, says: "We would again finally express the wish that we could try the powers of other projectiles besides those of Holtzer; he himself has protested against his 6-in. shot delivered in 1889 being taken as a sample of what he could now supply, excellent as they were for their day. Cannot Elswick—Sir W. G. Armstrong, Mitchell and Co. supply us with some of its Wheeler-Sterling (American) shot? It is only fair to our own plates to forestall the objection, which will naturally be made abroad, to calculations based

on our trials made with Holtzer shot only." Here we have two tests of what are considered superior thick plates treated by the Krupp process, but with some doubt as to the quality of the projectiles used.

On May 29, 1897, the Carnegie Steel Company, U. S.A., presented for test at Indian Head a 12-in. experimental plate of re-forged nickel-steel face-hardened armor, which was attacked with one Holtzer and one Wheeler-Sterling 12-in. projectile. There were no cracks. The first impact was with a Holtzer armor-piercing projectile weighing 850 lbs., with striking velocity of 1,811 foot-seconds; the point of the projectile just perforated the back bulge. The projectile, which seemed to be a good one, broke up; some few fragments got through, but the bulk of it fell in front of the plate. The Wheeler-Sterling projectile of 850 lb. weight was fired with a striking velocity of 1,769 foot-seconds; it smashed on the plate, a portion of the head remaining in the impact. By the formula this plate should be perforated by a 12-in. projectile of 850 lb., with a velocity of 1,696 foot-seconds, whereas it was just defeated by a velocity of 1,811 foot-seconds—*i. e.*, 115 foot-seconds more than that required for perforation. The Carnegie plate, to have been equal to the Krupp plate, should have defeated an 850-lb. projectile at 1,846 foot-seconds; it fell short of it by 35 foot-seconds. The angle of impact in the case of the Krupp plate was 9 deg. from the normal, while in the case of the Carnegie plate the impacts were exactly normal. The former plate was slightly cracked after three impacts, while the latter showed no signs of cracking after two rounds. All in all, it may be fairly said that this Carnegie plate is fully as good as that of Krupp. In comparing the tests, the velocities used must not alone be considered, but the striking energy due to weight and velocity, as the projectiles used against the Carnegie plate weighed 850 lb., as against 712.6 lb. of Krupp and 714 of Vickers.

None of these three were service plates. The two former are quoted to illustrate the development reached abroad with thick plates treated by the Krupp process, and the latter that reached in this country by other means than the Krupp process, showing that the difference is slight.

There is no question but that Krupp armor has been, and is, equal to, if not superior to the armor of England, France, Russia, and Austria, but it is equally certain that armor made in this country has been fully equal to any service armor made abroad.

It is reported that on account of the good showing made by Krupp with his 11.8-in. plate, he received a contract for armor for the Russian battleship Poltava, a vessel of 10,950 tons displacement, carrying a 15.7-in. belt and turrets of 10-in. thickness.; but the nature of the ballistic requirements for this armor are not given. From the fact, however, that the Russian armor made in this country was not required to withstand as severe a test as that made for United States vessels, it is reasonable to suppose that the test required for the Poltava armor was not unduly severe. The price paid for this armor was £104 15s. and £108 11s. per ton, delivered in St. Petersburg.

The advent of the Krupp plate evidently created some stir among the British armor makers, for it was soon reported that they had adopted his process, and in March, 1897, the English firm of Vickers, Sons and Co. presented for test a 6-in. plate, which was officially tested, under the direction of the British Admiralty. It successfully resisted, without perforation or serious cracking, the attack of five 6-in. Holtzer projectiles

of 100 lb. weight, having a striking velocity of 1,960 foot-seconds. The plate was reported as of Harveyed nickel steel, containing 4 per cent. of nickel, but is believed to have been treated by the Krupp process, as Vickers is known to have acquired it. The test applied to a 6-in. plate in the United States is less severe than that given to this experimental plate, and heretofore has consisted of one low velocity or cracking shot at 1,472 foot-seconds, and one high velocity shot for penetration at 1,959 foot-seconds. The calculated velocity—verified by practice— for the perforation of 6-in. plates by a 6-in. projectile is 2,084 foot-seconds, and it is proper to say that while our acceptance test is lower than that applied to the Vickers plate. Six-inch plates of American manufacture, have shown on subsequent attacks that they were capable of standing much higher velocities of impact than those required or than those applied to the Vickers plate. Six-inch plates of American manufacture, not special plates, but for ordinary service or for test of projectile, have successfully resisted numerous impacts with velocities of 1,986 foot-seconds, and in January, 1897, a Carnegie 6-in. plate furnished to test projectiles received impacts from 35 6-in. projectiles, the majority of them at velocities greater than those required to insure perforation of ordinary service plate. It must again be noted that the Vickers plate was attacked by Holtzer projectiles, which renders it impossible to make an exact comparison with American plates tested with American projectiles. The most recent Admiralty requirements are that a plate 8 ft. square by 6 in. thick shall resist five Holtzer steel projectiles of 100 lb. weight at 1,920 foot-seconds striking velocity without serious cracking, but we cannot learn as yet that any contracts have been made under these requirements.

Brown and Co. on July 20, 1897, submitted two 6-in. plates, which were officially tested by the British Admiralty under the same conditions as the Vickers plate, and both successfully fulfilled the requirements. In July, 1896, a 7-in. re-forged plate, representing the 8-in. turrets of the U. S. S. Iowa, made by Carnegie, after passing the regular ballistic test for acceptance, consisting of two impacts of a 6-in. projectile at striking velocities of 1,620 and 1,816 foot-seconds, giving a penetration of 2 in. and 3 in. respectively, was further tested with ten 6-in. projectiles of 2,100 foot-seconds, giving penetration of from 2 in. to 3.75 in.

In September, 1896, the British Admiralty tested a 6-in. plate made by Cammell, under circumstances similar to the test of the Vickers plate; it was reported as of Harveyed nickel steel, and made an excellent showing, but not quite equal to that presented by Vickers. Very likely this plate was treated by the Krupp process.

Beardmore, in Scotland, is reported to have taken a contract for armor for a Danish monitor, under ballistic requirements as high or higher than the Vickers plate quoted, and is said to have thrown up the contract.

No conclusive results or wholly satisfactory information concerning the value of the so-called Krupp process can be arrived at except by means of tests made by ourselves.

The American armor makers have acquired the rights to use it, because they wish to bid on foreign contracts, and to do so must be on an equality with foreign manufacturers. They are not prepared to make armor by the Krupp process, and cannot even state approximately when they will be able to submit a trial plate—though they expect ultimately to do so—and cannot guarantee that their first effort will be successful. They say they would not be willing at the present time nor the near future

to take a contract under materially more exacting ballistic requirements than the last contracts for armor made by the Krupp or any other process, nor can they name a price for such armor.

As an item of interesting information, the last bids for Russian armor, the contract for which has not yet been awarded, are given, as follows; times for delivery, fourteen to eighteen months:

Vickers, Sons and Co., £116 16s. per ton; John Brown and Co., £113 18s. per ton; St. Chamond, £98 to £109 12s.; Le Creusot, £99 12s. to £113 12s.; Chatillon, £97 5s. to £112 12s.; Marrel Frères, £106 to £76 8s.; Krupp, £112 9s.; Dillingen, £111 17s.; Bethlehem, £106 2s.; Carnegie, £106 2s.; Wilkowitz (Austria), £90 9s.

My convictions are that armor manufactured in this country is fully equal to the best service armor yet manufactured abroad; that the tests as heretofore applied have been such as to secure a high standard, and that they are as severe as those heretofore applied abroad and represent more fully the actual quality of the armor supplied, more so than does the method of testing in vogue in England; that the armor presented in this country would have withstood tests considerably more severe than those to which it was subjected, and that the tests are and have been reasonable to the contractors, and so drawn as to carefully protect the interests of the Government. In the specifications recently prepared, which it is prepared to use in case of future contracts, a new table of velocities has been inserted, making the tests more severe than heretofore.

In testing armor in this country the plates of a group are carried on together until all are carbonized; there is usually one more plate than the number required; the inspector at this stage selects the plate which in his opinion is the poorest of the group for the ballistic test. It is understood that in England a small plate or plates of the size and thickness submitted by the armor manufacturer for the standard of his manufacture, is carried along with the group, and such plate or plates are used for the ballistic test instead of one of the plates of the group, so that their test is not as representative a one as is ours. It is the custom for the armor makers of Great Britain to submit from time to time experimental armor plates for test. Such plates are tested by the Admiralty, and those making the best records are adopted as the standards which must be reached by the manufacturer to whom a contract is awarded. This naturally leads to considerable rivalry among the armor manufacturers, and the extensive ship-building programmes always being carried on in England, and the natural desire for prestige, warrant the expenditure of time and money to develop new and improved quality of armor, and while the manufacturers may combine to regulate the cost of armor for ships of the Royal Navy, as England builds ships of war for several foreign governments, the makers of what may be termed "champion plates" naturally stand the best chance for orders, both domestic and foreign; hence the incentive to excel is very great. It will be observed that there is no fixed ballistic standard except such as is made by the test of champion plates.

In this country the conditions are somewhat different, the Navy Department having heretofore established the ballistic requirements for all armor manufactured, the last ones being based upon the de Marre formula for determining the velocities necessary to insure perforation of high carbon steel plates and backing, plus fifteen per cent. for face-hardened armor. The specifications for armor for the Kearsarge and Ken-

tucky are based upon the foregoing, and the actual velocities used against the ballistic plates, representing groups of armor, are, in the case of thick plates, about 14½ per cent. lower than that required for perforation for the high velocity shot, and about 35 per cent. less for the low velocity shot; for thin plates the high velocity shot is about 20 per cent. less than that required for perforation, and about 30 per cent. less for the low velocity shot.

These requirements seeming somewhat irregular, the new proposition is to fire two high velocity shots, both of which have a velocity of 17 per cent. less than that required for perforation. After the first shot there shall be no through crack in the plate, nor shall the projectile or any fragment thereof pass entirely through the plate and backing, and no part of the shell is to pass, on the second shot, entirely through the plate and backing. It is believed that these requirements insure armor of as good resisting quality as is in use in any country. It is impossible for any one to say that the maximum degree of excellence has been reached in the manufacture of armor; and in this country, where the demand is so limited, the best way to encourage the development and improvement of armor would be to make the ballistic requirements as high as is prudent and reasonable, and when making contracts to offer a premium of a fixed sum on such ballistic groups as may excel, by some specified amount, the contract requirements. This is the method adopted in France; a premium of 5 per cent. on armor at £80 would be but £4 per ton, or £10,000 on 2,500 tons of armor at that price, supposing it all earned the premium. It is not unlikely that the American armor makers would be willing to accept higher ballistic requirements if they were permitted to carry along with each group special plates of 6-in. thickness to be used for the ballistic test, as it is reported is done in England, but such a measure would not be calculated to secure service armor of the best quality. At present the Bureau of Ordnance sees no good reason for increasing the ballistic requirements beyond the point proposed and heretofore stated, but does favor the payment of premiums for greater excellence. While the English firms of John Brown and Co., Cammell and Co., and Vickers, Sons and Co., the French firm of St. Chamond, and the American firms of the Bethlehem Iron Company and the Carnegie Steel Company have acquired the right to manufacture under the Krupp process, the development of that process and its status in this country at the present time is not such as to warrant its consideration in connection with the armor for the new battleships Nos. 7, 8 and 9. The future alone will reveal its value, so far as its manufacture in the United States is concerned. The proposition outlined as to premiums will probably secure the best armor that can now be made in this country for these vessels.

An experimental plate is now being made in this country, and should be ready for test in a few weeks. It is made by the Chase-Gantt process; it was cast 18 in. thick, in a mould faced with ferrochrome and some other substances. It was then forged down to 10 in. in thickness and tempered, that is, face-hardened. It is not known as yet with what degree of uniformity such plates can be reproduced, or what ballistic showing it will make, nor at what cost such plates can be produced, but probably cheaper than by the Harvey process.

It is reported from abroad that the Krupp process will be more costly than the Harvey process. The Krupp process is not patented, but is a trade secret. It is not improbable that the carbonizing is done by means

of a hydrocarbon gas instead of the former method of cementation. It has been learned that the Russian government did not accept any of the bids herein referred to, and it was understood that they contemplated making the armor themselves; it is also rumored that the contract will again be placed on the market.

In 1887 and 1890 this Government offered premiums for armor possessing qualities superior to contract requirements, but the introduction of nickel steel and face-hardened plates upset calculations for the time being; the problem is now sufficiently well understood to warrant a return to that method. There is a clause in all our contracts which provides that any new or improved methods that may be developed may be required by the Government, but this implies modification in price, and is so stated.—*The Engineer.*

TEST OF A SPECIALLY PREPARED PROJECTILE.

An official trial of a specially prepared projectile was successfully carried out at Messrs. Vickers, Sons and Maxim's range at Swanley, recently, in the presence of representatives of the Admiralty and War Office. The trial was of considerable interest, as it is well known that after a gun has been fired many hundreds of rounds the velocities fall off to some extent, due to erosion and other causes. The point of difference whereby this projectile differed from others was that an arrangement was screwed on to the base of the shell by which a specially prepared ring was made to expand in the eroded portion of the bore so as to overcome the injurious effect of erosion, caused by smokeless powders, as well as to prevent the shot being over-rammed, should the bore be worn by this or other causes. The general principle of the gas check depends upon the compression of this specially constructed ring by an annular copper ring, which conveys pressure to the specially constructed ring in such a manner that the specially constructed ring makes a perfect metallic seal against the bore, and completely prevents any gas at a high temperature and pressure passing the base of the shot, and hence does away with the principal cause of erosion in guns. Four rounds were fired with this specially banded shot, and four with the ordinary service shot, and it was found that the whole of the energy of the gun was restored after upwards of 250 rounds had been previously fired. The actual ballistics obtained were 2,694 feet per second for a pressure of 13 tons with a 25-lb. charge of cordite. By increasing the charge by a moderate amount and slightly increasing the initial chamber pressure, a velocity of 2,900 feet per second could reasonably be expected. It is claimed that this simple application is capable of being applied to almost any design of shell at a very moderate cost, and by its application it is confidently expected that guns after firing many hundred of rounds will be equally efficient, as far as energy is concerned, to a new gun.—*Journal of the Royal United Service Institution.*

THE VICKERS 6-INCH QUICK-FIRING GUN.

It would be difficult to overrate the importance of efficiency in a 6-in. gun at the present moment. In action the heavy guns fire but slowly, their effect may be very great, but the number of rounds got off from

them in a critical period may probably be too small to eliminate the elements of uncertainty. The very light quick-firing pieces are so much exposed that it is a question if they could be fought at all in close action. Consequently the fire that many officers depend on mainly is that of the heavier quick-firing guns, and in the British service these are 6-in. pieces, protected by 6 in. of steel in all our best vessels. Speed and power in our 6-in. quick-firing guns, then, is especially to be desired, and hence the importance of the 6-in. gun brought out recently by Messrs. Vickers, first tried on board the Pincher gunboat at Portsmouth on October 21 last, subsequently at Shoeburyness, and adopted for the service in January last. Its length of bore is 45 calibers, and its weight 7 tons 8 cwt. It is of wire construction, and proportioned to bear the prolonged pressure of its large charge of 25 lb. of cordite during the passage of the shot up the bore. It will be seen that the mounting carries a small curved shield of special nickel-treated steel, which has been proved to possess high resisting power, although the steel is able to be brought to the abrupt curve needed for the shield.

There are three leading features in the gun as put forward and tried: (1) great energy; (2) special breech action, giving ease and speed of working; and (3) obturation sufficiently complete to enable the metal cartridge commonly used in quick-firing guns to be dispensed with. On the day of trial at Portsmouth a muzzle velocity was attained with a 100-lb. projectile of 2,784 foot-seconds, implying a muzzle energy of 5,373 foot-tons, and a perforation of 22.7 in. of iron by Tresidder's formula. This, it need hardly be said, is extraordinary, the greatest perforation laid down in the service table for a 6-in. gun being 15.9 in. of iron. In stating this, we feel it necessary to recognize that it is extremely difficult to maintain such a performance as the gun continues in use. Very rapid fire with very large charges of cordite involves an amount of wear that it is very difficult to resist. Messrs. Vickers, however, have confidence in having arrived at effectual means of prevention.

To come to the second leading feature, that is, ease and speed of working. The screw is made on a system embodying the Weling patent. For the interrupted thread of the French system is substituted in the portions or segments differences in radius exceeding the height of the screw thread, which may consequently be continued throughout, except where a break or interruption is made to take the segment whose thread stands highest. This succession of steps may be repeated. It occurs twice in the 6-in. gun. In the 12-in.gun the succession of steps is repeated three times. In each case there is a considerable gain in the length of screw thread bearing, as compared with the French interrupted system. The screw and mechanism of the 12-in., as may be seen, are very light compared with the large diameter of the bore. The advantage is perhaps still more apparent in the 12-in. than in the 6-in. In this three-quarters of the circumference of the screw are used for effective thread section, only one-quarter of the circumference being non-screwed. On this account the screw can be made lighter and shorter than in other types, and consequently a lighter carrier can be used, and the manipulation is rendered more easy and rapid. Further, the shortness of the screw admits of the gun itself being shortened at the breech, that is at the heaviest part, and great weight is saved which can be utilized elsewhere. Both the 12-in. and 6-in. mechanisms have practically the same system of firing gear. There is an automatic tube-ejector which throws out the primer when the breech is opened. The tube can be placed in the vent either with the breech open or closed, and in the case of a misfire it

is not necessary to open the breech to withdraw the tube. Safety gear exists, rendering it impossible to fire the gun without the breech being closed and locked either on the electrical or the percussion-firing system.

Returning to the 6-in. quick-firing piece, the third leading feature in the gun is obturation dispensing with the use of a metal cartridge. This is facilitated by the shortness of screw, so that it has been found that the De Bange obturator can be rendered efficient. The advantages of this are obvious; the doing away with the metal case saves weight and magazine room, and saving of weight facilitates the rapid and easy working of the gun. There is also probably a saving in expense. No ejection of case being required, mechanism is simplified. Throughout the trials at Portsmouth and Shoeburyness the breech mechanism worked with complete ease, the tube was satisfactorily ejected automatically, and the obturation was complete. The heating of the metal was also watched, and considered to be well under the needed limit of temperature.

The Shoeburyness trial took place on January 13 in the presence of the representatives of the War Office and Admiralty. The object of this further trial was to test the accuracy of the gun after having fired upwards of 200 rounds, including the rounds fired at the proof of the gun; and also to submit the gun to a further test for rapidity, under conditions of service, using a 100-lb. shot, a cordite charge, and service primers. The trial commenced with a series of ten rounds, the result of which showed that the accuracy of the gun had not fallen off in consequence of the great amount of work already done by it. On the contrary, on two occasions the projectiles pased through the same hole in the target.

Suspension of firing then occurred, due to the weather becoming overcast, but in the afternoon it cleared, and the rapidity series was successfully completed. This series was conducted by a crew of seamen gunners specially sent by H. M. S. Excellent for the purpose, and were in charge of Lieutenant-Commander J. Murray Aynesley, the experimental officer of the gunnery school at Portsmouth. Thirty-six rounds were fired in four minutes forty-seven seconds, and this time included taking temperatures of the vent head, which operation was considered desirable, owing to the very rapid rate of fire. This rate of fire gives practically one round per each eight seconds, or at the rate of one hundred rounds in thirteen and one-third minutes, which, for practical considerations, allowing one hundred seconds for cooling during the hundred rounds—this extra time would probably be necessary for the supply of ammunition on board ship—would give a rate of fire of one hundred rounds in fifteen minutes.

For a short series of rounds such as one would expect in an engagement of, say, from ten to twenty rounds fired intermittently, an even greater rate of fire would be obtained. Analyzing the rounds fired during the trial, the maximum rate of fire attained was one round in six and one-half seconds, and eight rounds were fired each taking seven seconds, and another eight rounds each taking seven and one-half seconds. The other rounds varied from eight to nine seconds.—*The Engineer.*

VICKERS' QUICK-FIRE FIELD GUN.

A trial of a quick-fire gun of Messrs. Vickers took place at Messrs. Vickers' range at Eynsford this week, in the presence of officers repre-

senting the War Office and Admiralty. As most of our readers are aware, the difficulties of applying quick fire to field guns are—first, the fact that it is esential that the gun should not require relaying each time it is fired; and secondly, the fact that the metal cases of quick-fire ammunition add greatly to the weight to be carried, and are troublesome. The recoil in guns mounted on decks and behind breastworks is generally partly checked, and the gun probably recovers its original position and laying by the action of springs, etc. In the field this has never hitherto been completely carried out, but there are various more or less successful arrangements. Vickers claim to have achieved this so as to render raising up unnecessary, both with howitzers and high-velocity pieces. The following description is supplied: "The recoil and subsequent return of the gun to the firing position are operated by a specially constructed device fixed under the protection of the trail, which is arranged to allow both the gun and mounting to recoil, thereby making use of the whole available mass for overcoming the energy of recoil, the result being that the jump is eliminated and the gun run out into the firing position without alteration of the slight alignment. One of the special points by which the system is characterized is that it readily admits of its application to existing artillery without any serious modification to the existing type of mounting, and the mounting when altered is, within a few points of percentage, equal in efficiency to an entirely new quick-fire field equipment. The total weight of the gun and mounting complete, including mechanism, wheels, quick-firing attachment, tools, etc., is 19 cwt. The weight of the limber is not here recorded, as this depends on the weight of the ammunition intended to be carried by any particular equipment.

"Twenty-seven rounds were fired in all, with charges of 16¼ oz. of ballistite, the weight of the shell being 13¼ lb., and a velocity of 1,650 foot-seconds was obtained for a pressure of 14 tons. Two rounds were first fired to exemplify generally the working of the system, after which fifteen rounds were fired for rapidity, each round being carefully laid on the target. These fifteen rounds were fired in 67 seconds, which gives a rate of fire of 13½ rounds per minute. A second series was then fired, during which the gun was very carefully laid and was placed pointing deliberately forty degrees off the target, and the time was taken from the gun's crew working the gun from this position into the alignment, and proceeding with the firing in such a manner as would take place when a gun was being taken into action on service, the time being taken for unlimbering. Under these circumstances ten rounds were fired in 125 seconds, or at the rate of five rounds per minute, each of the rounds being carefully laid on the bull's-eye. Six rounds were then fired from a mountain equipment at the 1,000-yards range, when excessively good shooting was obtained, but the shooting under these circumstances is not now specially reported, as the equipment was one of which the results are well known, and which is being successfully used in Egypt, this type of gun having made excellent shooting recently at the battle of the Atbara.

"It is of interest to note that the Egyptian Government are now in possession of six complete batteries of these guns, which use shells of 12½ lb., and 20 lb. double shell when desired.

"At present metal cartridges are used, but it is claimed that they can be dispensed with, as in the 6-in. quick-firing gun, the De Bange pad being used."—*The Engineer*.

A NEW METHOD OF MAKING HARD-FACED ARMOR.

Taking advantage of the fact that by suitably controlling the process of cooling, it is possible to obtain some of the newer alloys of iron with nickel, cobalt and manganese in either a hard or a malleable condition, M. Jean Werth, manager of the Société Anonyme des Hauts Fourneaux et Aciéries de Denain et Anzin, has devised a new process of making armor plate. M. Werth's contention is that the plate should have the same chemical composition throughout, and that the hard face should be obtained entirely by a process of tempering. Ordinary carbon steel in large masses cannot be tempered satisfactorily, but when alloyed with suitable proportions of nickel, cobalt or manganese it is possible to obtain the metal in a hard state by heating it up to a bright red and allowing it to cool in the air; whereas, if heated only to a dull red and cooled, the metal will be malleable and comparatively soft. The steel used by M. Werth is open-hearth metal, free from sulphur and phosphorus. It contains from 5 per cent. to 15 per cent. of nickel or cobalt, and from 2 to 12 per cent. of manganese, whilst within certain limits silicon, chromium or tungsten may be present without interfering with the process of tempering. In its soft state such a steel has a tensile strength of 110,000 lb. to 140,000 lb. per square inch, and a strip 1¼ in. thick can be bent without cracking round a radius equal to its thickness. After the plate is completed, it is tempered by making it part of the side or bottom of the furnace. The face next the fire thus becomes heated to a bright red, whilst by means of water or air the temperature of the back face is kept down to 800 deg. or 900 deg. Fahr. To insure good results the heating is effected very gradually, the plate being put into a cold furnace; and by preference gas fuel is employed in the latter. Another method of effecting the heating, which is, however, only applicable to flat plates, is to immerse their front faces in a bath of red-hot lead, the temperature of which is maintained very uniform. When ready, the plate is removed from the furnace and cooled at the back, until the front face has sunk down to a temperature of 800 deg. to 900 deg. Fahr., when no further attention is required, though if warped it can now be straightened before the cooling is finished.—*Engineering.*

THE UNITED STATES NAVY—GOOD AND BAD POINTS.

The present war will certainly throw much light on various problems of naval architecture which are now but vaguely understood, and it may solve them completely and satisfactorily. Already the superior points of the navy have been demonstrated and its weaknesses made manifest. The most important and prominent fact has been the reliability of the ships, considered as a unit, and the capability of the several types for the work they were designed for. A continuous and hard duty for several weeks, cruising under high pressure, and repeatedly employing all the guns, has failed to show a single defect of a serious nature in either hull, machinery or armament. The protective qualities of the boats have not been tested in the slightest degree.

Too much praise cannot be extended to the designers and builders of the propelling machinery. The uncertainty which has been felt as to whether this portion of a naval vessel would stand long-continued service has been removed. That this doubt existed was shown by the statement of the late Admiral Meade, at a meeting of the Naval Architects and Marine Engineers, two or three years since, that he would like to have one of the fast cruisers attempt to follow one of the Atlantic liners in a trip to Europe, the object being to practically test the staying qualities of the cruiser. The seagoing ability of the battleships has been proved by the wonderful voyage of the Oregon, which joined the fleet off Cuba in every respect able to do her full share of the work.

The monitors were intended for coast defense. Their limited coal capacity and consequent exceedingly small radius of action make it impossible for them to be independently useful at any considerable distance from a base of supplies. This was illustrated during the movement of the fleet toward Cuba, when coaling at sea was necessary, and when the speed of the fleet had to be regulated by that of the monitors. Those characteristics also prevent the monitor class assuming a position in a naval engagement—it must be content to fight in the position its quicker enemy chooses to place it. Its seagoing ability has also been criticised. For coast defense the monitor, with its tremendous power, ample protection and small target presented, will undoubtedly prove to be of the greatest use. An unknown factor is found in the ram Katahdin. Whether this vessel will occupy a niche peculiar to itself remains to be seen.

The big guns and their turrets have worked without a hitch. At the present time the life of these guns, or the number of times they can be fired with full service charges, is not known with any degree of certainty. It is possible that the experience now being gained may lead to experiments with guns of greater caliber length than any now employed. Experiments have been made abroad with lengths as great as 50 and 60 times the bore, but the results are more or less uncertain. The American built-up gun would appear to lend itself to this extension, and if such should prove to be the case the advantages gained would be of the utmost value. The good resulting from the use of smokeless powder has been shown by the New Orleans. According to the dispatches, the rapid dissipation of the light smoke from her guns permitted their being handled more rapidly than those using ordinary powder.

In addition to a general weakness in numbers in all the types, the American Navy is particularly feeble in torpedo boats and torpedo-boat destroyers, and in high-speed, partially-protected scouts or dispatch boats.

With so many experts watching for points of excellence or features of weakness, we may expect a thorough account at the close of the war. With the public thoroughly aroused to the necessity of possessing the best vessels, equipped in the most modern way, there can be little doubt that Congress will promptly vote the necessary appropriations.—*Iron Age.*

RIGHTS AND DUTIES OF BELLIGERENTS AND NEUTRALS.

At the Royal United Service Institution, on May 19, Mr. J. Macdonell, LL. D., Master of the Supreme Court, delivered a lecture on

"Recent Changes in the Rights and Duties of Belligerents and Neutrals according to International Law." Sir Robert Giffen, K. C. B., presided.

Mr. Macdonell said that when he arranged with the secretary, about six weeks ago, respecting his lecture, he did not anticipate that the subject would have the living interest which it now possessed. He proceeded to point out how international law was in a state of rapid transition, and that much that was taught in books on the subject had become obsolete. Among the great changes affecting international law were the decline in the belief in the "law of nature" and in the influence of Roman law; the doctrine of the equality of States was also no longer accepted as it once was; international law was now based on a community of civilization, and another great change was the growth of "military realism"—a spirit which found eloquent expression in much of the military literature of Germany. In dealing with the chief recent changes which have taken place in international law, he took as the starting-point the close of the Crimean war. In 1856 the great powers issued the Declaration of Paris, of which the history was still shrouded in some mystery. Neither Lord Clarendon nor Lord Cowley, the diplomatists more directly concerned, gave a full account of the negotiations; the only detached statement was one published by M. Drouyn de Lhuys, who was French foreign minister at the time. According to that statement—it was borne out by the remarks which fell from Lord Clarendon—that declaration would have been made by the bulk of civilized States whether we had acceded to it or not. Referring to the abolition of privateering, he remarked that perhaps the growing sense of humanity and the recollection of the squalid abuses connected with privateering had something to do with its disuse. But much was due to this fact—the transformation of a merchant vessel into an efficient cruiser was not so easy as it was in the days of Paul Jones or Jean Bart. When that transformation was practicable there was little in the Declaration of Paris to prevent it. Article 2 provided that "the neutral flag covers enemies' goods, with the exception of contraband of war." This closed a long controversy, in which England had, on the whole, consistently maintained her right to seize an enemy's goods wherever found. It was not clear that we could have prevented a general affirmation by the civilized world of the principle, "free ships make free goods." It was not clear that we could have maintained our ancient principle without provoking the hostility of neutral nations, and it was still less clear that we could now rescind what we did in 1856. One could not lose sight of the fact that exemption from capture on sea was probably for a long time to come out of the question. Such exemption would be in war to the supreme advantage of England, which stood to lose so much. The Declaration of Paris did not deal with contraband of war, and he could not say that as to this in recent years, either here or elsewhere, there had been any distinct change. No prize courts had for many years sat in this country. When they went to war they would see them applying doctrines and principles of a startling character, and highly unfavorable to neutrals—doctrines and principles formed at a time when belligerents were a law unto themselves. Members of Parliament had lately asked the Government again and again whether they intended to prohibit the exportation of contraband. The Crown had power under the customs act, 1879, to prohibit the exportation of certain kinds of contraband—a power, however, which was rarely exercised. A vessel might be contraband, and the fitting of it out might also be an

infringement of the foreign enlistment act, but, speaking generally, there was no power to prohibit the exportation of contraband; the risk of capture was the only penalty. The foreign enlistment act of 1870 made our neutrality law more rigorous than that of any other country. It was the outcome of the complaints of the United States Government as to the defects of our neutrality law in allowing the escape of the Alabama. The English act of 1819 was based on the American statute of 1818, but was in several respects more stringent, and, as he had said, the statute of 1870 still further increased the stringency of English law. But no change of any kind was made in the United States statute. The consequence was that many things punishable here were not so according to American law, and they were not punishable under most other systems. As they were all aware, too, our Government undertook by the Treaty of Washington of 1871 to observe in the future three rules then formulated and to bring them to the notice of other countries. No other nation had adopted these rules, which many jurists treated as unreasonably onerous to neutrals. He was inclined to think that the act of 1870 and the rules of 1871, properly understood, did not go beyond what was reasonable; but it was more heroic than prudent to admit the existence of these duties without insisting on or asking for reciprocity or giving some explanation of the sense in which we understood them. The only occasion on which these rules were construed—at the Geneva arbitration—they received an interpretation which every English lawyer repudiated. In recent wars in which maritime operations have been carried on on a large scale, the chief controversies had turned on the duties of neutrals to belligerents. The events of the last few weeks suggested several desirable modifications in the interest of neutrals. A neutral must be prepared to put up with many inconveniences from operations conducive to the termination of war, but it was plain that the present laws of war permitted of acts which might profoundly injure the neutral without, perhaps, greatly aiding the belligerents or conducing to the close of hostilities. Recalling the effect on the price of wheat here and elsewhere, the far-spreading consequences of the rise caused by vague alarms of capture, let them conceive what would follow from a blockade, maintained even for a few weeks, of the chief American ports. Suppose that in a war between Germany and Russia the ports of the latter were sealed, and that no wheat from Russia was procurable at a time when harvests in America and other countries usually supplying us with wheat were bad, should all neutrals consent to starve in order that the ring might be kept for the combatants and the game of war be played out in the good old way? For the common benefit of civilization, the maintenance and use of certain machinery, plant and services were necessary. The treatment of submarine cables in time of war was a still more difficult and important question, and one as to which international law had so far failed to give any clear guidance. No one could say with confidence what would be its development as to this point. An international convention was entered into at Paris on March 14, 1884, for the protection of telegraphic communication by means of submarine cables; but Article 15 expressly stated that the convention was not to interfere with belligerent rights. Probably effectual safety against the danger here referred to was to be found in the multiplication of lines of communication; but pending extensive developments of telegraphic enterprise it was hard to contemplate calmly the possibility of England's being cut off from India or some

of her colonies, not by her enemies, but by a State professing to be friendly to her, in order to injure some other State. It seemed to him that in any satisfactory convention there should be an article binding the signatories not to cut or injure cables connecting countries with their colonies or dependencies. That the strict enforcement of belligerents' rights as laid down in the text-books would be here ruinous to neutrals, that the new maritime law, slowly disengaging itself from precedents and traditions, must here, as elsewhere, take greater notice of the interests of neutrals—that was the reflection with which he ended. —*United Service Gazette.*

BELLIGERENTS AND NEUTRALS.

The second and concluding lecture by Mr. J. Macdonell, C. B., LL. D., Master of the Supreme Court, on "Recent Changes in the Rights and Duties of Belligerents and Neutrals according to International Law," was delivered on the 2nd inst. at the Royal United Service Institution. Major-General J. F. Maurice, C. B., presided.

Dealing with the recent practice of beginning hostilities before a formal declaration of war, which, it will be remembered, caused difficulty in the American-Spanish war owing to the capture of Spanish and French prizes, Dr. Macdonell pointed out that this was no new source of trouble. Although the ancients always first declared war, the Romans making the occasion one of pomp and ceremony, there was no expressed condition, and a change was introduced in the last century. Great Britain, for instance, refused to give up prizes to France, although taken before the declaration. Such declaration was no longer regarded as obligatory, and even the withdrawal of diplomatic agents might not precede the outbreak of hostilities. Such change and difference of opinion might involve great difficulties, say, with shipowners or shipbuilders, whose obligations as subjects of neutral States could not clearly be recognized. Thus, the lecturer pointed out, a shipbuilder on the Clyde might hand over munitions of war to a belligerent after hostilities had been commenced in a corner of Africa, of the existence of which place the shipbuilder had never heard. Jurists were divided still as to when some of the great wars of this century actually commenced, and thus it was a matter of great importance that some agreement should be come to. On the subject of the severing of submarine cables, Dr. Macdonell had much to say, but he was clearly of opinion that a belligerent had the right to cut a cable even if it terminated on neutral soil, and he instanced the case of Britain being at war, and using the cable which touches at Lisbon for communicating instructions to colonial ports. Obviously the enemy would cut such an important line, which led to the suggestion that it was most undesirable for us to have important telegraphic connections through such small States, which were very liable to be coerced by a powerful enemy. Our trust should not be laid in any chapter of accidents to see us through such a difficulty. The lecturer alluded to the greater humanity of the soldier and of the recognized practice of saving national and private treasures, but he disagreed with most jurists in the view that the outbreak of war made void the debts of the citizens of one State to those of the other belligerent. He urged soldiers and the jurists to combine in the preparation of a first-class comprehensive manual for international guidance.—*United Service Gazette.*

TRIAL OF NEW TORPEDO NETS.

The new torpedo nets tried on H. M. S. Hannibal, have been definitely adopted for service, and the Hannibal, when commissioned, will be equipped with them. They weigh about 30 cwt. per net, half as much again as the old style, but are said to be "quite as easy to handle." I have not seen them in operation, but "quite as easy to handle" is a vague term. Ships have been known to take nearly twenty-four hours getting out their nets, while others have done it in two hours. In part, of course, this has had to do with the crew, but structural peculiarities and often individual peculiarities of individual ships have had as much or more effect. In any case, however, the Admiralty are to be congratulated on their diligence and pertinacity in seeking to solve the problem that—as mentioned last week—both France and Germany have abandoned as hopeless. It is very nearly a cardinal axiom with modern naval officers, that if a torpedo boat finds a ship she will "get home" without much trouble. Of course, the ship's safety lies in the immense difficulty of a boat finding her in war time. I have been in a "boat" and passed within torpedo range of a ship at anchor without a soul on board knowing it; the lost chance was only discovered when the ship opened fire some while after she had been passed by the way. On the other hand, I have known a torpedo miss at a range of 30 yards, or thereabouts, that is, one-tenth of what is considered almost certain range. A ship is a very small target when a boat is steaming fast. In theory, a torpedo will travel 1,000 yards, in experimental practice it will find the target nine times out of ten at 400 yards; in manœuvres the chances are even that it will hit at 300 yards—in war time they will be certainly half that again. But on the other hand, the ship's chances of hitting the boat are still less, nor is it proved that one hit, or even several, will stop a boat. From the time the boat is sighted until the torpedo is fired is—despite the manœuvre claims of two minutes under fire—seldom over one minute, and to hit a boat enough to stop her way in sixty seconds will need some very good shooting.

In connection with torpedo boat attack and defense, it is pretty generally known now that the orders for war time are—fire at every boat. Whether it be friend or foe must be discovered later. It is a regrettable thing that in our annual manœuvres we never properly test this question of what is to happen to the friendly boat, by allotting torpedo boats to each side. In connection with this, it is currently reported in the service that a well-known torpedo officer recently informed the Admiralty that he had a device whereby a friendly boat could make its presence known on board a battleship without visible signal of any sort. The Admiralty, however, refused to allow the money necessary to carry out the experiments, so it remains a secret; presumably it was some adoption of wireless telegraphy. The French are said to be in possession of some such device.

TRIALS OF DUTCH CRUISERS.

In our issue of February 21, 1896, we gave some particulars of the water-tube boilers which were to be placed in three second-class cruisers that were then being built for the Royal Navy of the Netherlands.

RESULTS OF TRIALS OF DUTCH CRUISERS.

Date.	Speed.	Revolutions.	Indicated Horse-Power.	Air Pressure in Water Height.	Number of Boilers.	Coal Consumption per Indicated Horse-Power.	Time.	REMARKS.
	knots					lb. per hour.	hours	
				Friesland.				
Oct. 18, 1897..	10.423	71.6	1,077	....	3 W.-T.	....	4	No auxiliary engines included in the coal consumption.
Oct. 19, 1897..	12.528	87.25	2,006	....	4 W.-T.	1.84	6	
Oct. 20, 1897..	17.275	124.2	5,982	0.4 in.	All 10	1.62	4	
Nov. 3, 1897..	19.87	147.27	10,416	0.8 in. to 1.16 in.	All 10	1.67	4	
Nov. 3, 1897..	Maximum	148 3	10,850		All 10	....		
				Zeeland.				
Dec. 28, 1897..	10.24	64.2	1,162	....	3 W.-T.	....	4	Propellers at 17½ ft.
Dec. 29, 1897..	12.4	78.6	2,062	....	4 W.-T.	....	6	
April 5, 1898..	19 47	138.58	9,818	1.2 in. to 2 in.	All 10	2 06	4	All auxiliary engines included in the coal consumption. Propellers at 16 ft.
April 5, 1898..	Maximum	141.5	10,589	1.2 in. to 2 in.	All 10	....	..	
April 6, 1898..	16.466	114.22	5,203	0.4 in.	All 10	2.1	4	
				No feed-heater was fitted in this case.				
				Holland.				
Feb. 6, 1898..	9.973	70.04	1,216	....	3 W.-T.	....	4	
Feb. 9, 1898..	11.63	80.51	1,778	....	4 W.-T.	....	6	
Feb. 24, 1898..	16.92	123.0	6,236	0.4 in.	All 10	....	4	
May 10, 1898..	19.618	145.86	10,541	0.8 in. to 2 in.	All 10	2 28	4	All auxiliary engines included in the coal consumption.
	Maximum	149.9	11,712	....	All 10	....	..	Ship had been docked lastly Feb. 4.

GENERAL REMARKS.—The indicated horse-power is the indicated horse-power of the chief engines only. The stokers on board the Zeeland and Holland had not been so well trained as on board the Friesland.

These vessels were the Holland, Friesland and Zeeland. It will be remembered that Mr. Andrae, the engineer-in-chief to the Dutch Navy, determined to try the result of a combination of small tube or express water-tube boilers and return-tube boilers in these vessels, and selected the Yarrow boiler as most suitable for the purpose. As a consequence, Messrs. Yarrow & Co. were commissioned to construct, at their works at Poplar, one Yarrow boiler for each ship, making three in all, and these were intended to act as examples for the remaining water-tube boilers required that were to be made in Holland. We have been furnished with the particulars of the trials of these vessels, but before repeating them it will be convenient if we give some details of the vessels themselves.

The Friesland has been built and engined by the Maatshappij voor Scheeps en Werktuigbouw Fijenoord at Rotterdam, an establishment of which Mr. Croll is the director; and the Zeeland by the Koninklijke Maatschappij de Schelde at Flushing, of which Mr. van Raalte is the director; whilst the Holland was built in the Royal Dockyard at Amsterdam, and engined by the Nederlandsche Fabriek van Werktuigen en Spoorweg Materieel at Amsterdam, of which Mr. Strumphler is the director. These vessels are 306 ft. long by 48 ft. 6 in. wide and 17 ft. 9 in. deep. The displacement is calculated at 3,900 tons with 400 tons of coal on board, the total coal supply being 850 tons. The vessels are twin-screw, and have triple-expansion engines with cylinders 33 in., 49 in. and 74 in. in diameter by 39-in. stroke. The propellers are 14 ft. by 16 ft., and have 60 square feet of surface. It may be noted that the propellers of the Holland turn outwards, and those of the other two ships inwards. The boilers, which are the most interesting part of the machinery, consist, in each ship, of two of the return-tube type, having a grate surface of 126 ft. and a heating surface of 4,005 ft. The eight water-tube boilers have 322 square feet of grate and a heating surface of 16,136 ft. As stated, Messrs. Yarrow made one boiler for each vessel, the remainder being constructed by the Dutch firms. The total maximum horse-power for which the boilers of each ship were designed to supply steam was 9,250 indicated. Of this, 2,250 horse-power was to be obtained from the two return-tube boilers, and the remaining 7,000 horse-power from the eight Yarrow boilers. The weight of the return-tube boilers with water was 120 tons, and that of the eight water-tube boilers with water 88 tons. The total weight of propelling engines and boilers and water, together with pumps, fans, funnels, floor-plates, ladders, and all other things which can be included under the category of propelling machinery, was for the Holland 635 tons, for the Friesland 611 tons, and for the Zeeland 570 tons. The Holland and Friesland have Weir's feed-pumps and feed-heaters. The Zeeland is fitted with Yarrow's automatic feed-control arrangement, and has a Worthington pump to each boiler, but has no feed-heater. There are steam steering engines, dynamos for electric light and for search-lights, air compressors for torpedoes, steam capstans, refrigeration engines, Sturtevant blowers for ventilating purposes and to supply hot or cold air, evaporators, feed-water filters, and other auxiliary machinery and fittings.

The results of the trials are given in the annexed table. The steam pressure in both return-tube and water-tube boilers was 200 lb. to the square inch.

The object of the Dutch naval authorities in adopting the combined arrangement of boilers was to gradually accustom the stokers to the new type. In three similar cruisers being built in Holland, and which

are to be launched shortly, Yarrow boilers only are being fitted; there being twelve in each vessel.

It may be interesting to compare the results obtained on the trials of these vessels with those of the Diadem, which affords an example of our most recent type of cruiser. Putting the weight of the machinery in the three Dutch vessels at 605 tons and the mean maximum horse-power at 10,260, we have 16.9 horse-power developed per ton weight of machinery. If the weight of the Diadem's machinery was 1,437 tons, and the horse-power developed 17,262 (see Sir John Durston's paper read at the last meeting of the Institution of Naval Architects), it will be seen that 12.01 horse-power was developed per ton weight of machinery. It must be borne in mind, however, that the Diadem's full-power trial extended over eight hours, while that of the Dutch cruisers was but of four hours' duration. If every allowance be made, however, there can be no doubt that the adoption of the express type of boiler gives an enormous advantage in regard to lightness of machinery, and therefore of speed; and it may be said generally that the results bear out the wisdom of the choice of the Dutch naval authorities.—*Engineering.*

SHIPS OF WAR.

[CHILI.]

O'HIGGINS.

The Chilian cruiser O'Higgins, which has just completed a series of trials, including twenty-four hours' seagoing speed, six hours' full speed, gunnery, turning, and other trials all of which have been carried through with complete success. The O'Higgins was designed by Mr. Philip Watts; the keel-plate was laid in April, 1896; the vessel was launched in May, 1897; and she is now about to leave for Chili, complete in every respect; the period of her completion in less than twelve months from launch is exceedingly short, when her size is considered, and the seven months' engineering strike which intervened is taken into account.

The dimensions of the O'Higgins are: Length, 412 ft.; beam, 62 ft. 9 in.; mean draught, 22 ft. At this draught the vessel displaces 8,500 tons, and carries 700 tons of coal, a complete outfit of provisions, stores, fresh water, etc., and all ammunition, torpedoes and equipment. This mean draught was maintained during the speed trials, which were made off the Tyne in the presence of Admiral Uribe and other members of the commission of Chilian officers appointed to superintend the construction of the vessel.

The machinery has been supplied by Messrs. Humphrys, Tennant and Co., and the boilers are of the Belleville type, being thirty in number, placed in three separate water-tight compartments. Owing to a strike of firemen engaged for the trial, the Chilian officers kindly gave the services of 100 Chilian stokers—part of the crew to take over the vessel when complete—and though these men were not accustomed to stoking the Belleville boilers, the trials were nevertheless carried through with complete success, an ample supply of steam being maintained throughout.

The full power of the engines is 16,000 indicated horses, but the twenty-four hours' trial was conducted at about three-fifths full power, and 10,000 indicated horse-power was exceeded during the whole time, giving a speed of over 19 knots. Turning circles were made after the trial to test the manœuvring qualities, and these showed that in 2 min. 6 sec. the O'Higgins could reverse her direction, both engines running full speed ahead, the tactical diameter being 3.4 times the under-water length of the vessel, the complete circle being less than three times her length; the heel of the vessel in turning never exceeded 4 deg.

The above trial was made on April 20, the full-power six hours' trial with natural draught being taken on the 26th. The mean of six runs over the measured mile course, taken consecutively with and against the tide, worked out at 21.52 knots, the last four runs giving a mean of 21.7 knots, which may therefore be taken as the full speed of the O'Higgins. It should be mentioned, however, that the vessel had never been docked since her launch, and though sheathed and coppered, it is probable that a certain amount of slime was adhering to her bottom, and it was afterwards found that numerous copper sheets were dislodged at the launch and repaired in dock after the speed trials.

The gunnery trials were made on two days, and finally completed after the six hours' trial, when, amongst other severe tests, seven guns were simultaneously fired direct ahead by an electrical discharge, no damage to ship or mountings resulting, with the exception of glass. These seven guns were three 8-in., two 6-in. and two 4.7-in. A similar test was applied aft, but with one 8-in., four 6-in. and two 4.7-in. The armament carried by the O'Higgins is not only exceptionally powerful, but is exceptionally well protected, all the four 8-in. guns being separately mounted on 6-in. armored barbettes, three forward and one aft, and protected by armored gun-houses, 7 in. and 5 in. thick, which completely enclose the guns; similar protection is given to the four 6-in. guns mounted on the upper deck. The remaining 6-in. guns—making ten in all—are placed on the main deck, within six casemates whose fronts are 6 in. and rears 5 in. thick. The ten 12-pounders and ten 6-pounders are protected by the ordinary shields, three torpedo tubes are also fitted in the stern above water, and two submerged, one on each broadside. All the armament, it need scarcely be stated, has been supplied from Elswick.

Besides the protection to the guns, the O'Higgins has a 7-in. to 5-in. belt, carried along two-thirds of her water-line, of Harveyed armor 7 ft. in depth; this belt is supported on the sloping sides of a complete protective deck, which varies in thickness from 1½ in. to 2 in. The conning tower is of 9 in.-armor, and armored tubes are provided for the supply of ammunition to all the guns. The vessel is unusually well fitted in all respects, with electric light and every modern improvement, and is certainly a most powerful addition to the already powerful Chilian navy.—*The Engineer.*

[ENGLAND.]

DIADEM.

The Diadem has been carrying out a further series of experimental trials, having been required to steam for four hours with a view to ascertaining whether she could, with only 78 per cent. of her boiler

heat, obtain the same power as was required of her at her full-power trial on the 26th of January. According to the contract stipulation, she then had to obtain, on eight hours' run, a mean of 16,500 I. H. P., but, as a fact, the mean obtained was as high as 17,188 I. H. P. Drawing 24 ft. 3 in. forward and 26 ft. 6 in. aft, with 291 lb. of steam in the boilers, and with a vacuum of 27.2 in. starboard and 26.3 port, she, on the 29th of January, worked up to 116.2 revolutions starboard and 115.4 port. The conditions of this trial and the previous ones thus offered some striking differences and similarities, for while on the last occasion the whole of the 30 boilers were in use, on the new trial only 24 were lighted up. The draught of water on each occasion, as well as the vacuum, was about the same; the steam in boilers was 291 lb. at both trials, while at the more exacting test there was a slight reduction in the number of the revolutions—namely, from 119.1 to 116.3. On this occasion, however, forced draught was used for the first time, but the air pressure amounted to only three-tenths of an inch, and the total I. H. P. was 8,168 starboard and 7,693 port, giving a collective I. H. P. of 15,861. This result gave a unit of power for less than two square feet of heating surface, which is the forced-draught surface allowed in cylindrical boilers in the Navy. Contrary to the usual practice at forced-draught trials, the coal consumption was taken, and worked out at the exceedingly low average of 1.95 lb. per I. H.P. per hour, thus further showing a considerable gain by the use of the improved Belleville boilers, while the power was easily maintained. The temperature in the stokeholds and engine room was comparatively low, and there was again a marked absence of dense smoke, flame and clinker from the funnels. The trial fully demonstrated that, should one boiler compartment be disabled in action, the design power of the ship could still be reached, and though the trial was limited to four hours, it was evident that the engines and the ship could have stood the test for a considerably longer period. It was also shown by the result of the trial that in no ship has such high evaporative efficiency been realized from the Belleville boiler. At the thirty hours' trial with four-fifths of her power some difficulty was experienced in consequence of the frequency with which the fusible plugs were blown out, but after that trial the faces of the plugs were so hammered out that none were blown from their positions during the trial on the 29th, and thus the use of the distillers for the supply of water to make good the loss of steam was obviated. As stated in previous reports, the ship was remarkably steady, no marked vibration being shown at any speed.

On the 6th ult. the cruiser continued her progressive trials in Stokes Bay. She first made four runs over the measured mile at 16 knots, then four runs at 14 knots, and, after swinging for the adjustment of compasses, four runs at 10 knots. In each set of runs the power and speed corresponded with the results that were anticipated from the model trials at Haslar experimental works. The mean of the first set of runs showed that 6,270 I. H.P. gave her a speed of 16,010 with 4,430 I. H. P., and the third set of runs gave a mean speed of 11.07 knots for 1,923 I. H. P. The trial was regarded as highly satisfactory.

On the 8th ult. she left for a further stage of her experimental trials, and anchored at Spithead the next evening. She first steamed for 15 hours with only eight boilers, and with 270 lb. of steam in the boilers and 250 lb. of steam at the engines. At this stage of the trial the revolutions were 64.3 starboard and 65.1 port, while the collective I. H. P.

was 3,266. The coal consumption worked out at 2.35 lb. per unit of power per hour, which was in fairly close keeping with her preliminary 30 hours' trial with the same power, when the consumption was 2.33 lb. During the second phase of the trial, which also lasted 15 hours, there were 260 lb. of steam in the boilers, but only 150 lb. at the engines. Sixteen boilers, however, were used, and it was found that with 88.9 revolutions starboard and 90.1 revolutions port, and with a collective I. H. P. of 7,119, the coal consumption was 1.94 lb. per unit of power per hour. Both stages of the trial justified the calculations of the Admiralty when the vessel was designed.

The final trial, concluded on the 11th ult., was for 30 hours, with only 24 boilers in use, in order to obtain data as to coal consumption. The draught of water forward was 24 ft. 4 in. and aft 26 ft. 9 in. The steam in the boilers was at a pressure of 265 lb. per square inch, the vacuum being 26.3 in. starboard and 25.7 in. port. The mean of the 30 hours gave 106.5 revolutions starboard and 108 port, and the collective I. H. P. was 12,852. The coal consumption worked out at 1.88 lb. per unit of power per hour. In this trial the vessel developed her maximum continuous steaming power with 78 per cent. of her boiler heating surface, and it was obtained under natural draught conditions, but with the fans moving slowly to ventilate the stokeholds. Although the coal was hand-picked, so much clinker was formed that after the first four hours of the run it was found necessary to clean out the fires every eight hours, but in spite of this drawback all the required results were obtained with only 2.45 square feet of heating surface per I. H. P. There was very little smoke and no flaming at the funnels. The course taken was from Spithead to Hastings, then a long run to the westward as far as the Scilly Islands, and then back to Spithead. The speed was not officially recorded, but the distance of 215 miles between Beachy Head and the Lizard was travelled in 10 hours 40 minutes, giving a speed of fully 20 knots, thus confirming the data obtained on the official runs between Ram Head and Dodman Point. The vessel has throughout the trials been uniformly successful, and though she has been favored, on the whole, with fine weather, she ran into a stiff breeze and a heavy sea early one morning, when her sea-keeping qualities were well tested, with the most satisfactory results.—*Journal of the Royal United Service Institution.*

HERMES.

The Fairfield Shipbuilding and Engineering Company, Glasgow, launched, on April 7, 1898, the second class cruiser Hermes, one of two of the same type ordered last spring. The keel was laid down on April 24, so that the vessel, of 5,600 tons displacement, has been launched within a year, notwithstanding the drawback of a fire which destroyed all the machinery and patterns, and delaying the work in the initial stages. This is the second cruiser launched this year, the first having been the 11,000-ton Argonaut, and in six weeks they will launch a third—the Highflyer; while in the same period they expect to lay the keel of two 12,000-ton armored cruisers, to be called the Cressy and the Aboukir. It may be interesting to compare the Hermes with some earlier second-class cruisers, to show the great progress which has been made under the *regime* of the present technical advisers of the Admiralty.

	"Magicienne."	"Latona" Class.	"Hermes."
	1887.	1890.	1898.
Length between perpendiculars	265 ft.	300 ft.	350 ft.
Beam	42 "	43 "	54 "
Draught (mean)	17 ft. 6 in.	16 ft. 6 in.	21 "
Displacement	2950 tons	3400 tons	5600 tons
Speed	19 knots	20 knots	19.5 knots
Protection	1½-in. deck	2-in. to 1-in. deck.	1½-in. to 3-in.
Armament	Six 6-in. b.-l. guns Nine 6-pdr. q.-f. One 3-pdr., One machine One boat gun Two torpedo tubes	Two 6-in. q.-f. Six 4.7-in. q.-f. Eight 6-pdr. One 3 pdr. Four machine One boat gun Four torp. tubes	Guns, 4⅞ in. Eleven 4.7-in. q.-f. Eight 12-pdr. Seven 3-pdr. Four machine One boat gun Two submarine tubes.
Normal coal capacity.	400	400	550
Complement	218	273	450

The design of the Hermes in one or two respects introduces improvements on the Venus class, of which the Fairfield Company built two, and of which in all, nine were constructed, the most notable change being in respect of guns and protection. In the Venus there were five 6-in. and six 4.7-in. quick-firing guns, and whereas in the new vessel it has been considered desirable in the interests of uniformity and to secure a larger supply of projectiles to make all the guns of 4.7-in. calibre; these latter fire a 45-lb. instead of a 100-lb. shot; but the difference in energy is not quite so great, the former having a penetration at the muzzle equal to 11.9 in., as compared with 16 in. of wrought iron, but there is a compensating advantage in greater rapidity of fire. In the auxiliary armament there is no change. In the Venus there was an armored cofferdam for the protection of the cylinders; but in the new ships the protective deck is raised to suit this change. The table we have given, however, shows the remarkable advance in second-class cruisers in ten years. The Hermes is 85 ft. longer than the Magicienne, 6 ft. more beam; while the displacement is almost doubled, the draught being increased by 3 ft. 6 in. This difference in weight represents superior qualities in every respect, in armament, in defense, and in radius of action. Some time age we had occasion to compare the Doris with the Latonia class (see *Engineering*, vol. lxi, page 776), but the ten years' advance is still more striking.

In the first place, the increased size of the hull gives not only a steadier but a higher freeboard. The guns on the poop and forecastle of the Magicienne were 18½ ft. above the water-line; in the Hermes they are 28½ ft. above the load-line forward and 19¼ ft. aft. As regards the attack, it will be seen that the new ships are immensely superior. They have eleven 4.7-in. quick-firers, against the six old breech-loaders. Three of the 4.7-in. guns fire ahead in line with the

keel, and three fire aft. The guns on either side are built partly on sponsons on the upper deck level, the bow guns having a radius of 6 deg. abaft the beam, and the after guns of 60 deg. forward the beam. The other 4.7-in. weapons are mounted on the broadside with a large arc forward and abaft the beam. These guns are all protected by 4½-in. armored shields. Two of the 12-pounder guns fire forward and two aft, the others being on the broadside, while the most of the 3-pounder guns are in the military tops. As to the supply of ammunition, the Hermes has magazines 58 ft. long in the forward part and 42 ft. aft, in all 100 ft., while in the Magicienne the combined length was only 54 ft., 28 ft. forward and 26 ft. aft. The increased beam (9 ft.) also adds greatly to the area of the magazines.

As to protection, there is an armored deck extending right fore and aft, curving 5 ft. below the water-line at the sides, and in the center it rises 1 ft. 6 in. above it. This deck ranges from 3 in. to 1½ in. in thickness, covering the whole of the propelling and steering machinery, boilers, magazines, etc. Reserve bunkers are on the protective deck over the machinery space and, whilst affording a water-line belt of coal protection, they give additional security in the event of damage, as they are subdivided into water-tight compartments. An armored conning tower of Harveyized steel is placed forward, fitted up with the usual means of navigating the vessel and directing operations while in action. The whole of the connections with the conning tower are protected by a steel tube extending to the protective deck. The Harveyized armor for the tower was supplied by Messrs. William Beardmore and Co., Glasgow. Bridges are fitted both at the fore and after ends for navigating the vessel under ordinary conditions, with the usual compasses, steering wheels, etc. Three search-lights are operated from these bridges.

As to the hull, it may be said that it is built of Siemens-Martin steel throughout, on the usual principle adopted in warship construction. There is a cellular bottom extending the full length of the engine and boiler spaces, and before and abaft these the water-tight flats of the magazines, etc., continue the double-bottom construction right to the stem and stern. Under the protective deck the side compartments for the full length of the boiler spaces are utilized for stowing coal, the normal capacity being 550 tons, although this quantity may be doubled by carrying fuel on the protective deck, as already indicated. The hull is subdivided by longitudinal and transverse bulkheads into numerous water-tight compartments, the water-tight doors being worked from the main deck as well as from below. The stern-post, struts, stem and rudder are of phosphor-bronze. The stem is of the usual ram form, and the structure behind is especially strong and efficiently connected to the general framework of the vessel, with a view to the contingency of ramming. The rudder is of the balanced type, and controlled by Harfield's compensating gear below the protective deck. The vessel, being intended for foreign service and long cruises at sea, in which the maintenance of a uniform speed becomes essential, has been completely covered to above the load water-line with teak of a minimum thickness of 3½ in. and coppered. To secure steadiness of gun platform, so necessary in a vessel intended for war purposes, bilge keels 23 in. deep have been fitted for a length of 140 ft.

As to the machinery, it is still more interesting to compare the ship now launched and the predecessors of the same class, the Marathon

and Magicienne, built ten years ago, and the Venus and Diana, completed in 1896. The table appended shows the leading dimensions in the respective classes.

	"Magicienne."	"Venus."	"Hermes."
	1889.	1896.	1898.
Diameter of high-pressure cylinders	34½ in.	33 in.	26 in.
Diameter of intermediate pressure cylinders	56 "	49 "	42 "
Diameter of low-pressure cylinders	76½ "	74 "	(2) 48 "
Length of stroke	3 ft.	3 ft. 3 in.	2 ft. 6 in.
Indicated horse-power	9000	9600	10,000
Steam pressure	155 lb.	155 lb.	300 lb. reduced to 250 lb. at engs.
Number of boilers	4 double-ended	8 single-ended	18 Belleville
Total heating surface	13,600 sq. ft.	18,740 sq. ft.	24,000 sq. ft.
Total grate surface	535 sq. ft.	634 sq. ft.	796 sq. ft.
Ratio of grate area to heating surface	....	1:29.56	1:30.15
Indicated horse-power per square foot of grate area.	....	15.14	12.56
Heating surface per indicated horse-power	....	1.95 sq. ft.	2.40 sq. ft.
Indicated horse-power per ton of boilers	....	17.3	22.2
Indicated horse-power per ton of all machinery	...	10.43	11.50

The first striking feature is the increase of steam pressure which has characterized all the ships built during the last four years, and is entirely due to the adoption of the water-tube steam generators. The Hermes has the Belleville boiler fitted with economizers, whereas the Marathon had double-ended multitubular boilers, and the Venus and Diana single-ended multitubular boilers. The result of the increased steam pressure is reflected in the ratio of the volumes of the high- and low-pressure cylinders, which, in the case of the Magicienne, is one to 4.917; in the Venus one to 5.028; and in the Hermes one to 6.81. The Hermes has two low-pressure cylinders to each set of engines, which is now the universal practice in the navy. In the matter of framing and material there has been no important change.

The increase in pressure, and the adoption of water-tube boilers, of course, has had a material influence in the reduction of weight. The total weight of the machinery in the case of the Venus and Diana was 920 tons, and in the case of the Hermes 870 tons; and it will be seen that whereas the Venus only developed 9,600 horse-power under forced-draught conditions, the ship now building will under natural-draught conditions develop a power of 10,000. The reduction in weight is entirely due to the boilers, and notwithstanding the increase of power, the complete boiler installation in the Hermes weighs only 450 tons, against 555 tons in the Venus.

There are 18 Belleville boilers in the Hermes, with nine elements in the "steam generator," the tubes in this case being, as is usual, of solid-drawn steel, and 4 in. external diameter; while in the economizers there are nine elements, the tubes being 2¾ in. external diameter. The space between the two forms the combustion chamber. In this type of boiler the width of the fire-grate is 8 ft., and the length of the fire-bars is 5 ft. 6⅜ in. The boilers are arranged in separate compartments, there being six in each boiler-room, arranged athwartships with the tubes running fore and aft; there are three funnels which are carried down to the top of the economizers. In each stokehold there is fitted a Weir's feed-pump, compressed air blowers for supplying air to the furnaces and combustion chambers, and fans for ventilating the stokehold, but the stokeholds are open. The coal bunkers are arranged on either side of the stokeholds, with an athwartship bunker at the forward end.

Turning now to the engines, it may be said that the cylinders are separate and independent castings bolted together, each fitted with a cast-iron barrel or liner, and arranged for jacketing in all cases. The cylinders and valves are arranged as follows, starting from the forward end: Flat slide valve, low-pressure cylinder, high-pressure cylinder, piston valve; piston valve, intermediate-pressure cylinder, low-pressure cylinder, flat valve. The two forward cranks work opposite to one another, and are arranged as close to each other as the centers of the cylinders admit. The other pair are similarly arranged, and have the cranks at right angles to the forward cranks. All the valves are controlled by the usual double-eccentric and link-motion gear. In front the cylinders are supported on forged steel columns, while at the back the usual cast-iron A frame is adopted.

The condensers are of brass and placed in the wings, the steam being condensed outside the tubes. The two centrifugal pumps are of gun-metal, and each is worked by an independent engine, but a cross connection has been arranged so that either or both condensers may be supplied with cooling water from either pump. The feed, bilge and hot-well engines are also independent, and an auxiliary condenser is fitted in each engine-room with separate circulating and air-pump for the auxiliary machinery.

The shafting is of forged steel, the cranks being 13 in. in diameter with an 8-in. hole, the line shafting is 12 in. in diameter with an 8-in. hole, and the propeller length is 14¼ in. in diameter with a 9-in. hole. The propellers are of gun-metal, each having three adjustable blades, the diameter being 12 ft. 9 in., and the pitch 13 ft. 6 in., and when running at a speed of 180 revolutions per minute the ship is expected to attain a speed of 19½ knots.—*Engineering.*

EUROPA.

H. M. first-class cruiser Europa is one of four vessels which follow, as it were, in the wake of the Powerful and Terrible, of which the Diadem is a type. The two sister ships are the Niobe and the Andromeda. The latter was launched in April last year at Pembroke, the Europa in the previous month at Clydebank, and the Niobe at Barrow on February 20th, so that they all took the water within little over two months. They are all of 11,000 tons displacement, 435 feet long by 69 feet beam, with a draught of 26 feet. They indicate 16,500 horse-power, and are propelled by twin screws. Their boilers are of the Belleville type.

The armament consists of sixteen 6-inch quick-firers, fourteen 12-pounder and twelve 3-pounder guns, and three torpedo tubes, two of which are submerged. The guns are protected by 4½-inch armor, and there is a 4-inch deck armor. The normal coal supply is very large, viz., 1000 tons, and their maximum speed is 20.5 knots. They cost over £560,000 each. There are four other ships in hand very similar to them—the Argonaut, launched at Fairfield in January last; the Amphitrite, being built at Barrow; the Ariadne, at Clydebank; and the Spartiate, at Pembroke. It is expected that these four vessels, which are of the same displacement, will have a greater speed by one-quarter of a knot, gained by running the engines faster.

The Europa left Portsmouth on the 3rd inst. for a thirty hours' run at 12,500 indicated horse-power, and arrived at Plymouth on Saturday night. She drew 24 feet 6 inches forward and 26 feet 6 inches aft. The steam pressure was 265 pounds, and the vacuum 24.8 inches and 25.5 inches in starboard and port engines respectively. The engines developed 12,379 indicated horse-power and 103.8 revolutions with a coal consumption of 1.94 pounds per unit of power per hour. During the trial she made four runs over the deep-sea course between Rame Head and Dodman Point, when, with 103.6 revolutions and 12,441 indicated horse-power, she realized a speed of 19.331 knots. The Diadem, the pioneer ship of the class, built and engined by the Fairfield Company at Glasgow, at her corresponding trial averaged 19.79 knots over the deep-sea course with a coal consumption of 1.59 pounds per unit of power per hour and 12,776 indicated horse-power. After coaling at Plymouth, the Europa left again on Tuesday morning for an eight hours' full-power trial, in which she made two runs over the deep-sea course. She had 279 pounds of steam in her boilers, and with 113 revolutions and 17,137 indicated horse-power she achieved a speed of 20.4 knots, but the mean of the eight hours gave a collective indicated horse-power of 17,010. The Diadem at the corresponding trial, with 17,188 indicated horse-power, gave a speed of 20.6 knots on the deep-sea course.—*The Engineer*.

Furious.

The Furious, cruiser, has completed the second of her coal consumption trials, which was 30 hours at 7003 horse-power. The course was from Start Point to the Scilly Islands, and the runs were made under the best conditions for steaming. The mean results were: Steam at engines, 210 pounds starboard, 210 pounds port; cut-off in high-pressure cylinders, 55 per cent starboard, 54 per cent port; vacuum, 27.8 inches starboard, 27.6 inches port; revolutions, 127.4 starboard, 128.4 port; mean pressure in cylinders—high, 72.2 pounds starboard, 73.3 pounds port; intermediate, 32 pounds starboard, 37.4 pounds port; low pressure, 15.9 pounds starboard, 14.4 pounds port. The indicated horse-power was—high pressure, 962 starboard and 986 port; intermediate, 1113 starboard and 1312 port; low pressure, 1452 starboard and 1330 port; total, 3527 starboard and 3628 port, making an aggregate horse-power of 7155. The coal consumption per indicated horse-power was 2.098 pounds, and the average speed 18.7 knots. In coal consumption and speed the trial was exceedingly satisfactory. The next trial will be at 10,000 horse-power.

The third of the series of trials of the cruiser Furious took place at Plymouth. On this occasion the trial was for eight hours at 10,000 horse-power. Com. R. B. Colmore was in charge. The conditions as regards

sea and weather were again favorable. The following were the mean results of the eight hours: Steam pressure at boilers, 256 pounds, reduced to 231 pounds in the starboard engine and 236 pounds in the port engine; vacuum 28 inches starboard, 27.1 inches port; revolutions 139.3 starboard, 142.3 port; the indicated horse-power was 5178 starboard, 5094 port—a total of 10,272. The average speed was 20.1 knots, which was satisfactory, being slightly better than that attained by the sister ship Arrogant on a similar trial a few months ago.—*Engineering.*

The Hogue.

The cruiser Hogue, which has just been ordered from Messrs. Vickers, Sons and Maxim, of Barrow-in-Furness, will, when ready to leave her builders, be sent to Devonport for completion, and to be permanently attached to that command. The Hogue is one of four vessels of the same type recently designed by Sir W. H. White, K. C. B., as an improvement on the Diadem class. She will be armored, and of the following dimensions: Length, 440 feet; breadth, 69 feet 6 inches; mean load draught, 26 feet 3 inches; displacement at load draught, 12,000 tons. She will thus be 5 feet longer and have a displacement of 1000 tons more than the Diadem, whilst she will be 60 feet shorter and of 2200 tons less displacement than the Powerful type of cruiser. The Hogue will have an armament much heavier than that carried by the Diadem, although the number of guns will be less. The armament, as at present arranged, will consist of two 9.2-inch breech-loading guns, twelve 6-inch and seventeen 6-pounder and 3-pounder quick-firing guns, and two submerged Whitehead torpedo tubes. She will be fitted with water-tube boilers and engines of 21,000 indicated horse-power, and is calculated to run at a speed of 21 knots an hour. Her bunkers will be capable of stowing 800 tons of coal, but this can be doubled if necessary by utilizing the wing and other spaces around the engine and boiler-rooms. The vessel will cost, when complete, about £650,000, of which sum no less than £260,000 will be spent on her by April next. An important feature in her construction will be her armor, this being the first armored cruiser designed since the Orlando type in 1885. Her bottom will be sheathed with wood, the material for which will be prepared at Devonport and sent round to the contractors to be fitted in place.—*The Engineer.*

Violet.

The new torpedo-boat destroyer Violet has completed her second stipulated three hours' 30-knot trial at Portsmouth successfully; the vessel encountered a beam wind, but on the whole the weather was favorable; the mean of the six runs on the measured mile showed that with 381 revolutions and 6600 I. H. P. the vessel had a speed of 30.014 knots; the highest speed attained during three hours was 30.8 knots, and the mean of the entire run was 30.16 knots, which was obtained with 381.2 revolutions and 6630 I. H. P.

Flying Fish.

The new torpedo-boat destroyer Flying Fish had her final steam trial at Portsmouth recently, when, with 6454 I. H. P. and 392.5 revolutions,

she obtained a mean speed on a three hours' run of 30.371 knots; the mean of six runs on the mile was a speed of 30.172 knots, with 390.7 revolutions; after the speed trial the vessel tried her steering machinery ahead and astern, both steam and hand gear being tested, and afterwards she had her starting and stopping trials, all of which were satisfactory.

TERRIBLE.

A further sixty hours' trial of the Terrible, first-class cruiser, was made on the 25th, 26th, 27th and 28th of last month, during her voyage from Portsmouth to Gibraltar, at two-fifths authorized natural draught power. A start was made off St. Catherine's at 2.30 P. M. on May 25th, and terminated at 10.30 A. M. on May 28th, after completion of which the ship was kept running at the same power until she reached Gibraltar in sixty-eight hours. The results, which are pronounced very satisfactory, are given in the accompanying statement:

Report of a 60 Hours' Trial of H. M. S. Terrible at 10,000 I. H. P.

Draught of water	Forward 28 ft. 2 in.	Aft 29 ft. 5 in.
Steam in boilers = 230 lb.	Starboard.	Port.
Vacuum	26.6 in.	26.5 in.
Revolutions per minute	81.1	81.42
Cut-off in H. P. cylinder, percentage of stroke	36.4	31.7
Mean pressure—High	49.29	57.38
Intermediate	23.77	22.14
1st low	9.48	9.50
2nd low	9.49	9.22
Indicated horse-power—High	1568.9	1825.8
Intermediate	1798.8	1682.5
1st low	846.5	850.9
2nd low	847.0	825.9
	5061.2	5185.1
Total power	10,246.3	
Total distance run	1020 knots.	

The average speed of the vessel was seventeen knots, and the coal consumption per indicated horse-power per hour for all purposes 1.89 pounds, whilst the gross total indicated horse-power developed was 10,246.3.—*The Engineer.*

ARIADNE.

The Clydebank Engineering and Shipbuilding Company, Limited, Glasgow, launched on April 22nd the Ariadne, a first-class cruiser of practically the type of the Europa, which was delivered for trial to the Admiralty a few days ago, and is now being prepared at Portsmouth for sea. The Ariadne is 462 feet 6 inches over all, and 435 feet between perpendiculars; her beam, extreme, is 69 feet, and her displacement 11,000 tons. There is a double bottom the full length of the machinery and boiler spaces, and, fore and aft, steel water-tight magazine flats continue the protection. Above the protective deck over the boiler spaces, and below alongside the boilers, are side compartments for the stowage of coal; and with the cross bunkers there is formed as complete a protection as is possible to the boilers. At the normal draught the coal capacity is 1000 tons, but there is provision for double that quantity of fuel should the necessity of carrying it arise. The subdivision of the hull by longitudinal and transverse bulkheads is exceptionally complete, and with so many water-tight com-

partments the vessel is as nearly unsinkable as a warship may be. In the bulkheads openings have been cut only where they are likely to be absolutely necessary, and the water-tight doors which have been fitted may be worked both on the spot and from the main deck. As is usual in warships that are sheathed, the stem, stern post and shaft brackets are of phosphor-bronze. The hull, up to about 6 feet over the water-line, is sheathed with teak planking, which, when the Dockyard takes the vessel over, will be coppered. There are bilge keels about 210 feet long and 3 feet deep. The rudder is a casting of phosphor-bronze plated with naval brass, and may be worked either by screw-steering gear actuated by duplicate engines, one in each engine-room, or by hand. All the steering apparatus is below the protective deck, which has a thickness ranging from 4 inches amidships to 2½ inches at the ends, extends the whole length of the vessel, and covers completely the machinery, boilers and magazines. The conning tower is of Harveyed steel, and the steering gear, shafting, voice tubes, etc., are protected as far as the protective deck by a steel tube 7 inches thick. The navigating bridges are as in other ships of the navy, but in the Ariadne the after one is higher, in order that the view of officers may not be obstructed by other deck erections and fittings. When the vessel is completed her armament will be: Four 6-inch quick-firing guns with shields—two on the upper deck aft and two on the forecastle deck; twelve 6-inch quick-firing guns in armor casements of Harveyed steel—eight on the main deck and four on the upper deck; fourteen 12-pounders and a large number of smaller and machine guns. There will also be two torpedo tubes, discharging under water forward. The complement of the vessel is about 700 officers and men, and, in addition to the accommodation for them, there is a suite of rooms for an admiral. The machinery consists of two sets of triple-expansion engines fitted in two water-tight compartments; each set has four inverted cylinders working on four cranks. The high-pressure cylinder is 34 inches in diameter, the intermediate 55½ inches in diameter, and each of the low-pressure 64 inches in diameter. All are adapted for a stroke of 4 feet. The cylinder covers are of cast steel, and the pistons, of conical shape, are also of cast steel. The high and intermediate cylinders are fitted with piston valves, and the low-pressure with treble-ported slide valves, with a relieving ring at the back, all the valves being worked by the usual double-eccentric and link-motion gear. Reversing is effected by means of double-cylinder steam engines, with gear of the all-round type, hand-gear also being available. The sole plates are of cast steel, and the cylinders are supported by cast-iron columns at the back, and forged-steel columns at the front. The main condensers are at the back of the engines, and constructed of cast brass in oval form; they are fitted with brass tubes ⅝ inch in diameter. The condensing water is supplied by four centrifugal pumps of gun metal, fitted with independent engines. Steam will be supplied by 30 water-tube boilers and economizers. The boilers are arranged in four groups, each group fitted in a water-tight compartment. They are designed to work at 300 pounds pressure, reducing valves being fitted to reduce the steam pressure to 250 pounds at the engines.—*Engineering.*

GOLIATH.

On March 23rd the first-class battle-ship Goliath, the first keel plate of which was laid on January 4th, 1897, was launched at Chatham. The

Goliath is 390 feet long between perpendiculars, has an extreme breadth of 74 feet, and a mean draught of 26 feet, and her displacement will be about 13,000 tons. This draught gives her a freeboard of 22 feet 6 inches forward, 19 feet amidships, and 19 feet aft. The side protection extends for 196 feet of the middle of her length, and from 5 feet below the water-line to 9 feet above it, the armor plating being of Harveyized steel 6 inches thick, while a belt of 2-inch nickel-steel armor runs right away in a broad streak along the water-line from the citadel to the stem and protects a width varying from 12 feet 6 inches to that of the whole depth of the stem below the main deck. This 2-inch, or 2½-inch, belt, including the skin plating of the ship, represents at least 6 inches of ordinary wrought-iron armor, and will constitute a formidable obstacle to projectiles from small Q. F. guns and is sufficient to burst common shell from guns of large calibre. The bow plating of the Goliath has, however, a very important duty to fulfill, independent of that of meeting the attack of small quick-firers. She has a cigar-shaped snout, and is supported internally by the 2-inch steel-armored deck and the elongated stiffening plate below, the breast hooks lending similar aid near the water-line. In the Resolution all these features are also found, but they are only held together by the steel framing of the ship and by the ordinary skin of 20-pound steel plates. The Goliath, on the other hand, has a double wall of nickel steel supporting the framing, 4 inches in combined thickness, and from 30 feet to 35 feet in depth. This could not possibly be turned aside by impact with the hull of an enemy, but would enter it like a cold chisel, and, after ripping open the plates, its very shape would facilitate the withdrawal of the ram uninjured. The filling in of the 3-foot spaced bulkheads with cork is also an additional safeguard, for it makes the stem a solid but elastic feature right back to the main collision bulkhead. The hollow stems of earlier vessels were always a source of possible danger. Then, again, in the ship now under consideration the double-bottom system is carried forward to the very forefoot itself. The longitudinals of the bracket framing are extended by intercostal portions to frames immediately behind the stem casting, thus preventing any working of the structure or of the armor plates covering it. At both ends of the armor belt rounded armor bulkheads are fitted of the same material, 12 inches, 10 inches, 8 inches and 6 inches thick. The barbettes at the forward ends of the battery are circular in plan, and are armored with Harveyized steel, the upper tier of plates being 12 inches and the lower 6 inches thick. The conning towers are circular in form, and both are 9 feet 6 inches thick. From the base of each tower a forged steel communicator tube of 4 inches internal diameter descends, the thickness of the forward one being 8 inches and of the after one 3 inches, inside of which are led the controlling shafts of the steering engines, engine-room, telegraph rods, and all the important voice tubes. The protective deck between the armored bulkhead is made of two thickness of half-inch steel plates, with additional 1-inch plates on the sloping sides. Beyond the limits of the side armor are a lower deck, protected by two thickness of 1-inch plates. The armament of the ship will consist of four breech-loading 12-inch 46-ton guns, on turntables, in circular redoubts, with all-around loading mountings, made by Messrs. Whitworth & Co., and they will be protected by shields, having 8-inch Harveyized steel in front, sides and rear, the floor plates being of 2-inch nickel steel and the crown plates of 2-inch mild steel. There are also twelve 6-inch Q. F. guns, eight being in 6-inch casemates on the main deck, while four are similarly

protected on the upper deck. The four end main-deck casemates have novel features, in that the guns can fire right forward and right aft respectively. Of ten 12-pounders (12-cwt.), six are placed on the upper deck amidship and four on the main deck fore and aft. Each of the fighting tops of the ship is armed with three 3-pounder Hotchkiss guns, the shelter deck forward with two 12-pounder boat and field guns, and the shelter deck aft, on the boat deck and bridges, with eight Maxim guns and six Howitzer guns. The ship is also fitted with four submerged tubes for 18-inch torpedoes, two on the broadsides forward and two aft. She will carry fourteen 18-inch and five 14-inch torpedoes, these latter for firing with dropping gear from the ship's steamboats.

The propelling machinery of the Goliath, which has been constructed by Messrs. Penn and Sons, of Greenwich, are of the vertical inverted expansion type, the cylinders being 30 inches, 49 inches and 80 inches in diameter respectively, and 4 feet 3 inches stroke. The main and auxiliary condensers in each engine-room are of brass. There are also in the engine-rooms two evaporators and distillers, four fire and bilge engines, four main centrifugal pumps, two hot-well pumps, one drain tank pump, two dynamos and engines. Three main and three auxiliary feed pumps are in the boiler-rooms. The ship is also fitted with two refrigerating machines, capable of reducing the temperature of a chamber of 1800 cubic feet capacity to 15° Fahr. after 12 hours working. Six search-lights are carried, one on the platform high up on each mast and two on each of the bridges. There are six positions for steering by steam, viz., fore-bridge, both conning towers, tower deck forward, and in both steering compartments. There are twin screws, 17 feet in diameter, and arranged so that the pitch can be varied. The I. H. P. of the engines is to be 13,500; speed of ship, 18½ knots. The ship carries 16 boats.—*Journal of the Royal United Service Gazette.*

Woodlark.

The official two hours' trial of the Woodlark, one of the shallow-draught armed river steamers recently ordered by the British Government, has lately taken place on the Thames. The vessel, which has been built by Messrs. John I. Thornycroft & Co., is 145 feet long and 24 feet broad. The draught of water was not to exceed 2 feet when loaded with 30 tons dead weight, and the speed under these conditions was to be 15 miles per hour. The mean draught of water on trial was found to be 1 foot 11½ inches, and the vessel covered 30¾ statute miles in two hours. She is armed with Q. F. and Maxim guns, and the sides above the water-line and the deck in the wake of the machinery are protected with Cammell's bullet-proof steel plating. The Woodlark is fitted with Thornycroft's twin screw-turbine propellers in raised tunnels, and is the fastest of the gunboats of this class hitherto constructed. Her speed astern was found to be 4¾ miles per hour, and she proved to be under control when going astern.—*Journal of the Royal United Service Institution.*

Angler.

The official trials of the Angler, torpedo-boat destroyer, were reported at Chatham on Saturday, April 14th inst., as follow: Speed of ship, 29.879 knots; steam pressure in boilers, 212 pounds per square inch; air pressure in stokeholds, 3.4 inches; vacuum in condensers, 25.7 starboard, 24.8 port;

revolutions per minute, 396.2 starboard, 388.6 port; mean indicated horse-power, 3003 starboard, 2859 port—total, 5862. The consumption of coal per indicated horse-power per hour has not yet been worked out.—*Engineering.*

WOLF.

H. M. S. Wolf has completed her official full-power speed trials on the Clyde, in the presence of the Admiralty representatives. Six runs were made on the measured mile with the following results:

	Steam.	Time.		Speed.
	lb.	min.	secs.	knots.
First mile	211	1	58½	30.46
Second mile	212	1	56½	30.98
Third mile	222	1	55½	31.25
Fourth mile	215	1	54½	31.41
Fifth mile	223	1	55½	31.25
Sixth mile	208	1	55½	31.14

The mean speed thus realized was 31.2 knots. After completing the six miles the vessel was taken outside the Cumbrae to complete the three hours' steaming at her contract speed of 30 knots, which was easily obtained, the results at the finish showing a speed of considerably over a quarter of a knot in excess of the contract. After completion of this trial, the usual steering trials at full speed ahead and astern were carried out, and the stopping, starting and reversing of the engines demonstrated for efficiency. The Wolf is the tenth 30-knot destroyer that Messrs. Laird have now completed for the British Admiralty.—*Engineering.*

POWERFUL.

Various and numerous inaccurate statements concerning the performance of the Powerful on her voyage to China have been diligently put in circulation by those who can find no good thing in her. One writer went so far as to say that the port engines will have to be lifted out of her and almost rebuilt. Last week we gave an explicit contradiction to those rumors. Mr. Allan, M. P. for Gateshead, did excellent service on Monday night by putting certain questions about the ship to Mr. Goschen. As far as construction is concerned the replies made by the First Lord of the Admiralty were quite satisfactory. There had been some heating of bearings in the course of a steam trial after leaving Mauritius—we gather that the white metal ran and had to be replaced. For five days the ship ran under easy steam with one screw until the bearings had been re-lined, and since, there has been no trouble. So far so well, but the consumption of coal seems to be very heavy. She had 2800 tons on board when leaving Portsmouth, at Las Palmas she took in 800 tons, at the Cape 2286 tons, at Mauritius 800 tons, at Colombo 2115 tons—or a total of 8300 tons, costing no less than £11,000. We do not know what power she exerted, nor what was her steaming time, all that will come out by-and-by, no doubt; but the figures given work out with rather remarkable results as compared with her trial trip performance. This it is known that the ship can steam 14 knots for about 5000 indicated horse-power. At 2 pounds per horse per hour, this gives us per day, say, 110 tons; this, divided into 8000 tons, gives us, in round numbers, 72 steaming days of 336 miles per day, or, in all, over 24,000 miles—or more than round the

world. This apparently shows that she burns much more than 2 pounds per horse per hour, even after due allowance has been made for auxiliary engines.

Gun and Steam Trials of H. M. S. Illustrious.

H. M. S. Illustrious, a battle-ship of the Majestic class, has completed her trials, and is preparing for commission. The results of the gunnery trials mark a very pronounced step in advance, for as a consequence of the introduction of many mechanical devices, the 12-inch 46-ton breech-loading guns were fired with a rapidity which almost justifies their being classed as quick-firing weapons. The guns are of the ordinary service type, firing an 850-pound projectile at a muzzle velocity of 2367 foot-seconds, equal to an energy of 33,020 foot-tons; and yet so complete is the operative mechanism that the only manual effort involved is the lifting of the charge in halves, each weighing 83 pounds, from the pockets in the loading hoist on to the loading tray. The two guns in the after turret were fired three times in 107 seconds from the first discharge to the last; the time between the second and third rounds was only 49 seconds, and this was accomplished by the ordinary crew from H. M. S. Excellent after only two or three days' practice. Doubtless, the ship's own company, when they get accustomed to the work, will improve upon this performance; but, as it is, it means that from the forward and after turret, trained on the enemy, 10,200 pounds of shot can be delivered in 107 seconds, and there is no reason why this rate should not be continued. This, when the energy (396,240 foot-tons) is noted, constitutes a vigorous attack which no ship could survive. While the gun and turret mechanism was designed by the late firm of Sir Joseph Whitworth & Co., at the Openshaw Works, prior to the amalgamation with the Armstrong Company, there is a certain appropriateness in the association of this advance in progress with the name of Armstrong, for it was Lord Armstrong who advocated and introduced the rapid-firing type of gun into naval warfare for guns of lighter calibre. Its immense importance was fully demonstrated during the recent conflict between China and Japan, and now the united firms have attained a like result with guns of large calibre, for, considering the weight of gun and ammunition, the rate of fire attained on these trials may, as we have said, be classed as "quick firing."

As we have said, the 12-inch guns of the Illustrious are similar to those in the other ships of the class—of 46 tons, wire-wound, and of Woolwich pattern, with the Woolwich hand-breech mechanism, which latter differs from the type previously employed. The older breech-loading guns, it will be remembered, had a mechanism with two distinct operations—the rotating of the screw plug by a Stanhope lever, and its withdrawal by the operation of a crank handle which first drew the plug to the rear, and afterwards swung the block and carrier ring about the axis pin, clear of the box. The new mechanism has a continuous motion operated by a handwheel, and effects the same functions as the old gear, but in a much shorter time; about 8 seconds when the gun is about the horizontal position, but a longer time is taken when the gun is being run in or out at the same time, or is at elevation.

Two guns of this type are fitted *en barbette* forward and two aft, both with armored protecting hoods, and the mountings for the Illustrious, as well as those for the Cæsar, were supplied from the Openshaw Works. They resemble in general idea the mountings fitted to the Barfleur, Cen-

turion, and Renown, and fully described in *Engineering*,* but many modifications have been introduced, and to these special reference may here be directed. The Centurion class carried 10-inch guns, and the operations of loading, etc., were performed primarily by hand gear, whereas in the new ships hydraulic power is used, the weights to be dealt with, both in respect of gun and ammunition being considerably heavier. The point of similarity between the two types of ships is that the shell chamber is carried underneath the gun platform, as described in our article on the Barfleur's gun mounting. The "ready supply" of ammunition is carried in this shell chamber and conducted directly to the loading position by hoists, so that the essential principle of all-round fire and loading at any position of training is maintained. In the Centurion class the weapon was balanced about its trunnions; but in the new ships, with the heavier ordnance, the gun and slide are balanced about the trunnions of the slide, so that the effort of elevating is minimized, a necessity in the case where the hand gear has to be resorted to in the event of any mishap to the hydraulic mechanism. The whole system of mounting, too, is balanced about its centre of rotation to meet the same desideratum. The centre of gravity coincides as nearly as possible with the centre of rotation, so that any heeling of the ship, permanently or temporarily, does not affect the force to be exerted in training the gun.

The powder is carried, as usual, in the magazines, from whence it is brought to the shell chamber by hoists working in a fixed central tube. Other hoists in the same tube bring shell, should the supply in the shell chamber become exhausted. The powder and shells thus brought up the central tube are transferred, as in the case of the ships of the Centurion class, to the hoists in the rear of the guns, which hoists act as loading trays when in their proper position. But in the case of the Illustrious the hoists are operated by hydraulic power instead of by hand or electrical power. The transport of shell in the shell chamber is also effected by two hydraulic power cranes, which transfer the shell from the bins or pockets and deposit them upon the loading trays on the upper hoists. The charges brought up at the last moment through the central tube are of sufficiently small weight to be readily handled and quickly transferred to powder pockets in the loading hoists, from which hydraulic rammers on the turntable push the shell and charge into the gun. In the event of the whole hydraulic system being disabled, the guns can still be loaded by hand power, an upper loading position and loading tray being provided for each gun within the hood, and simple means are adopted for hauling the shell from the shell chamber, or the magazine, to this upper loading position, when, as in the case of the Centurion class, they can be pushed into the gun by hand rammers.

The rotation of the turret is effected by hydraulic turning engines, so arranged that when the hydraulic power is cut off from the engine, a powerful brake holds the turning mechanism and prevents further rotation. On the gun platform is an auxiliary hand pump, which can be operated by the gun's crew and thus run the gun in and out, elevate the gun, or open the breech, to which the hydraulic mechanism is applied. The brake system for controlling the recoil of the gun is independent of the run in and out system; the brakes are self-contained and control the recoil very much in the same way as in an ordinary hydraulic recoil mounting, while the run in and out system is connected with the service

* See *Engineering*, vol. lvii, pages 358 and 415.

pressure from the main pumping engines, and serves for manœuvring the gun on its slide in either direction, or this may be done by hand gear, but much more slowly. In this connection it may be stated that the slight break-down in the case of the Cæsar a few weeks ago, about which so much was made in the daily press, was not in connection with the general design of the mounting at all. The Cæsar had long since successfully passed through her gunnery trials, but on the occasion of the commissioning trials in January, it was decided to try experimentally a new form of valve on the run-out cylinder, but this proved unsatisfactory. The valve fitted on the Illustrious differs from the form experimentally tried; and, indeed, the Cæsar was fitted with the same valve as the Illustrious with equally good results.

In addition to the hand gear for the breech mechanism, hydraulic gear is fitted, the hand gear being arranged so that it can be disconnected. The hydraulic is more rapid in its operation; the breech can be opened or closed when the gun is at its maximum elevation—13½ deg.—in 5 seconds. Not only so, but the operation of opening or closing can proceed during the period when the gun is being brought to the loading or firing position, which effects a saving in time in the manipulation of the gun. In effect these hydraulic operations render the 12-inch gun with its high ballistic qualities a quick-firing weapon; no effort being involved on the part of the gunner, except in the pulling of the levers, admitting water pressure to the rams operating the mechanism. The control of the mounting is effected, as usual, from two sighting stations, one on each side, to which positions are brought the various levers and handwheels for training and elevating the guns, as well as the automatic sights. The operating levers for controlling the hoists, rammer and running in and out of the gun are conveniently placed in rear of the sighting station of the gun platform within the view and control of the captain of the turret. Auxiliary elevating levers are also provided on the gun platform, and there is a complete duplicate service of hydraulic pressure pipes in addition to the usual central pivot supply.

At the official trials last week several rounds were fired first from the guns in the fore barbette, to test the effect on the decks of the ship. The first shot was fired from the right gun at 80 deg. before the beam, with an elevation of 1½ deg. The left gun was next fired with a reduced charge on the same bearings. In the third round the right gun fired a reduced charge with ½ deg. elevation, and in the fourth round the left gun fired a full charge at 1½ deg. elevation. The fifth and sixth rounds were fired right ahead with about ½ deg. of elevation, and as it was found that no material damage was done to the decks, further trials on this score were deemed unnecessary. The two guns were next fired with the hand gear alone in use, both guns being fired simultaneously, the left gun at extreme depression and the other at extreme elevation. The object of the trials of the two after guns was to determine the time required, and in this respect an unparalleled record was made. The guns were fired simultaneously, and the time which elapsed from the firing of the first to the discharge of the third round was 107 seconds, during which six shots of 850 pounds were fired. For guns of such calibre this may be regarded as extraordinary, and is a speed which has never been approached in any navy. The time between the second and third rounds was 49 seconds, and these results, as we have already stated, were obtained with an ordinary crew from H. M. S. Excellent after a few days' drill.

It must be borne in mind too, that with this all-round system of loading, the gun, once it has been trained, can be kept on the enemy during the whole operation of loading, and therefore no time is lost in bringing to "bearing" between each discharge, so that for all practical purposes the rapidity of fire on trial was under conditions of warfare. The loading, too, was done with the gun at an elevation of 13½ deg. Representatives were present from both Elswick and Openshaw on behalf of the contractors, and the trials, it may be added, have given great satisfaction to the authorities and all concerned.

Prior to the gun trials the Illustrious completed her steaming trials in the English Channel and North Sea; these were somewhat protracted owing to difficulties experienced with the Martin's system of induced draught fitted. The engines were constructed by Messrs. Penn & Sons, Greenwich, who were represented by Mr. J. Dixon, to whom we offer our congratulations on his appointment as manager at Messrs. Penn's. The engines are of the triple-expansion type, with cylinders 40 inches, 59 inches and 88 inches in diameter by 4 feet 3 inches stroke, and were designed to develop 10,000 indicated horse-power on an eight hours'

Description of trial		30 hours' coal consumption	8 hours' natural draught	4 hours' induced draught
Draught of water	Forward	25 ft. 7 in.	25 ft. 11 in.	25 ft. 5 in.
	Aft	26 ft. 6 in.	26 ft. 6 in.	26 ft. 6 in.
Actual load on safety valves, lb		155	155	155
Vacuum in uptakes, inches of water		nil	1.6	1.96
Average pressure in boilers		142	147	152
Average pressure at engines		140	145	151
Receiver pressures	H.-P.	139	144	148
	I.-P.	31	57	64
	L.-P.	4	13	17
Average vacuum, inches of water		26.5	27.2	27.2
Mean cut-off in high-pressure cylinders		40 per cent.	64 per cent.	—
Mean Pressure in cylinders	H.-P.	43.45	49.05	56.15
	I.-P.	15.35	25.45	28.4
	L.-P.	7.75	12.3	14.5
Mean number of revolutions per minute		83.05	96.45	99.5
Indicated horse-power, total		6155	10,241	12,112
Force of wind		5	4	—
State of sea		Short sea	Smooth	Very rough
Coal used per indicated horse-power per hour, lb		1.77	Not taken	Not taken

natural draught trial, and 12,000 indicated horse-power on an induced-draught trial of four hours' duration. The designed speed for the former power was 16½ knots, and for the latter 17½ knots, which has easily been realized with other ships of the same class, so that there was no need to ascertain the speed on this occasion. The twin propellers have four blades, the diameter being 16 feet 11¾ inches and the mean pitch 19 feet 9⅜ inches. The results on the three trials are given in the table above.

The New Armored Cruisers.

The Admiralty have this week given out the orders for the four armored cruisers which it was decided to build in July of last year, when the treasury made a supplementary grant to the Navy. Messrs. Vickers, Sons and Maxim, Limited, will build one of these vessels at Barrow-in-Furness, the Fairfield Shipbuilding and Engineering Company, Limited, will construct two, and the Clydebank Company, Limited, have been given the contract for the fourth.

The new vessels differ from the eight ships of the Diadem and Ariadne classes in having a side armor for the greater part of the length, and as more powerful machinery is arranged for, the speed will be greater. Their armament, too, will be the same as in the Powerful and Terrible, so that while intended for cruisers they almost rank as battle-ships, and will be able to take a place in the line of battle. The cost, completed, including guns, will work out to about 630,000*l.*, while the Powerful and Terrible cost 750,000*l.*, and the Diadem class an average of about 575,000*l.*; so that in view of the superior qualities over the latter, especially in respect of protection and speed, it will be recognized that Sir William White and Sir John Durston, the two technical officers chiefly responsible, have arranged a type of ship which will not only be efficient, but represent good value for the taxpayer's money, a point never forgotten at the Admiralty. The following table gives a comparison between the three latest types of modern cruisers:

—	"Cressy" Class.	"Ariadne" Class	"Powerful" Class.
Length, between perpendiculars	440 ft.	435 ft.	500 ft.
Beam	69 ft. 6 in.	69 ft.	71 ft.
Draught	26 ft. 3 in.	25 ft. 3 in.	27 ft.
Weight of hull	7860	6975	8480
Displacement	12,000	11,000	14,200
Side armor	6 in.	—	—
Casemates	6 in.	6 in.	6 in.
Protective deck	3 in. and 2 in.	4 in. and 2½ in.	4 in.
Armament	Two 9.2-in. B-L.; twelve 6-in. q.-f.; 17 small q.-f.; two sub. tor. tubes	Sixteen 6-inch q.-f.; 17 small q.-f.; two sub. tor. tubes	Two 9.2-in. B-L.; twelve 6-in. q.-f.; thirty small q.-f.; two sub. tor. tubes
Indicated horse-power	21,000	18,000	25,000
Speed	21	20¾	22
Normal coal capacity *	800	1000	1500

The details of construction are similar in all three types—double-bottom cellular system with longitudinal frames, extending up to the protective deck, or 5 feet below load line, to which the protective deck is connected, and on which the side armor in the Cressy class is constructed, as in all our battle-ships. This double construction gives a great security to the ship. All the ships are sheathed with teak 4 inches thick and coppered.

* The coal supply can be greatly increased, on emergency, to 2000 tons in Cressy and Ariadne, and 2500 tons in Powerful classes.

The armor belt extends for about 230 feet of the length of the ship, and is 240 pounds thick with 4 inches of backing. This belt is 11 feet 6 inches deep, extending 5 feet below and 6 feet 6 inches above the load line, the ordinary shell plating above that being 22½ pounds thick; but as in previous cruisers, all the 6-inch guns are within 6-inch armored casemates. The belt extends to within 120 feet of the stem and 90 feet of the stern, and there extends athwart the ship a bulkhead of 200 pounds in thickness. And here it may be said that all the armor is of nickel steel hardened by the new process, which gives a resistance to penetration by projectiles quite double that possible six or seven years ago, so that the 6-inch armor here is far superior to the 10-inch armor in some comparatively recent ships. The side armor does not, as in all previous ships, terminate at the bulkheads; but is continued, although of less thickness, right to the ram, as in the new battle-ships of the Canopus class. This is of 2-inch nickel steel in addition to the shell plating, so that at least all explosive shells will be kept out of the ship. At the stern, abaft the armored bulkhead, the shell plating is greatly increased in thickness, and the protective deck reinforced with the same object in view. Here the protective deck is 80 pounds thick; whereas within the citadel, formed by the side armor and bulkheads, it is 60 pounds. The main deck is also of more than usual thickness—40 pounds—to assist in protection; while, as usual, the coal bunkers are arranged on either side, from all of which it will be appreciated that while giving adequate weight for a high speed, and without relinquishing one jot or title of the elements of strength, the director of naval construction has given a protection equal to our latest battle-ships and superior to nearly all preceding ships. As to the arrangement of decks—protective, lower, main, upper and boat deck—the vessels are all alike; the Powerful and Terrible only have poops.

The main armament consists of two 9.2-inch 22-ton breech-loading guns, each mounted in barbettes, with 240-pound nickel steel hardened, and with a gun shield of 6 inches thickness. These barbettes are within the armored bulkheads, and the 12-inch conning tower, with 3-inch armored communication tubes, is further aft. There are two bridges and two conning towers, one forward and the other aft. These main guns have an arc of training of 135 deg., and will probably have an angle of elevation of 13 deg. For bow fire there is on the main deck a 6-inch gun on either side, and above, on the upper deck, on either side of the forecastle another, so that four 6-inch guns fire in line of the keel to 28 deg. abaft the beam. The 9.2-inch gun aft is on the upper deck—there being no poop, while four 6-inch guns also fire astern to 28 deg. forward of the beam. There are two 6-inch guns firing on either broadside with an arc of 120 deg. In addition, there will be twelve 12-pounder guns, two of which augment the bow fire and two fire astern. There are five other machine guns. There are two masts, but the tops only carry search-lights.

The appearance of the ships will be pretty much the same as that of the Diadem, with four funnels for the four boiler-rooms, each of which is 32 feet 6 inches long, the three after being 44 feet broad with two rows of four boilers, and the forward compartment 34 feet broad with two rows of three boilers. This is practically the same as in the Diadem, and here also special attention has been paid to ventilation, a large number of fans being provided with electric motors.

As to the machinery, the following dimensions may be tabulated:

—	"Cressy" Class.	"Ariadne" Class.	*"Powerful" Class.
High-pressure cylinder.....in.	36	34	45
Intermediate-pressure cylinder.. "	59	55½	70
Low-pressure cylinder..... "	68	64	76
Low-pressure cylinder..... "	68	64	76
Stroke.....	48	48	48
Revolutions.....	120	120	120
Indicated horse-power.....	21,000	18,000	25,000
Number of Belleville boilers.....	30	30	48
Heating surface.....sq. ft.	51,500	45,900	69,453
Grate area..... "	1,650	1,449	2,192
Pressure at boilers..... lb.	300	300	260
Pressure at engines..... "	250	250	210
Weight of machinery .....tons	1800	1550	2250
Indicated horse-power.....per ton	11.61	11.8	11.11
Square feet of heating surface per indicated horse-power.....	2.45	2.55	2.77
Indicated horse-power per square foot of grate	12.7	12.4	11.40

The engines are, as in previous cases, to be of the inverted direct-acting type, each set having one high, one intermediate, and two low-pressure cylinders. In the Cressy class one of the low-pressure cylinders is to be placed forward of the high-pressure and the other aft of the intermediate cylinder. The crankshaft will be in two interchangeable parts, each part having two cranks placed directly opposite. The Yarrow-Schlick-Tweedy system is to be adopted in some of the ships. The propellers work inwards, and the starting platform is to be at the centre of the ship. The cylinders will be supported in the front by wrought-steel pillars, the back columns will be cast iron, connected together at the top with suitable tie-plates. The frames for the main bearings will be of cast steel tied together, each set of engines being independent of each other. The valves of the high-pressure and intermediate cylinders will be of the piston type, one to each cylinder. Those for the low-pressure will be of the double-ported flat form (one to each cylinder), with a relief ring at the back. All the valves will be actuated by means of double eccentrics and link motion, separate provision being made for adjusting the cut-off in each cylinder. The valve setting will be arranged so that the power developed by the two low-pressure cylinders combined shall equal that of the high or intermediate cylinders.

Each set of main engines will have one vertical air pump worked by means of links and levers from the high-pressure crosshead. The main condensers are to have a total cooling surface of 21,000 square inches. The two auxiliary condensers will have 3000 square feet of heating surface. There will be four circulating pumps with 48-inch impellers, the duty being 1400 tons from the bilges per hour.

The crankshafts are to be of 19 inches external diameter with a 10-inch

*The designed results are given for comparison. These were exceeded just as the results in the Cressy class may be.

hole, the crankpins of 21 inches external diameter with 12-inch hole, those for the high-pressure and intermediate-pressure engines being 24 inches long, and for the low-pressure, 16 inches. The main bearings are to have a total length of about 14 feet, and the thrust surface will be 2500 square inches. The propeller shaft is to be 19½ inches external diameter, with a 10½-inch hole. The propellers are to be about 18 feet in diameter.

As indicated in the table, there will be 30 boilers of the Belleville type with economizer; the heating surface in the steam-generating tubes will be 33,500 square feet and in the economizer small tubes 18,000 square feet, a total of 51,500 square feet; the grate surface being 1650 feet. The tubes will be solid drawn, 4½ inches external diameter for the generators and 2¾ inches for the economizers. The fans for the stokehold will be of the double-breasted type; 12 of them will be 6 feet 6 inches in diameter and four of them 6 feet in diameter. The two pumps for the hot well will be of the crankshaft type, while there will be eight feed pumps. The capacity provided for feed water is 116 tons. The grease extractor will have 15,750 square inches of filtering area. There will be four fire and bilge pumps having a duty of 100 tons per hour.

Of the other auxiliary machinery, it may be said that there will be four evaporators of 108 tons capacity, two distillers of 54 tons capacity, three electric-light generators, two steering engines, two sets of air-compressing pumps and four reservoirs, two boat hoists, two refrigerating engines of the cold air type, coal hoists, ash hoists, etc., as usual.—*Engineering.*

Official Speed Trials of War-Ships.

An official return shows the speed trials of warships. Of torpedo destroyers, fifteen have passed successfully through the trials during the past year, one of them being a 27-knot boat, while the others are 30-knot design. Messrs. Laird, of Birkenhead, and Messrs. Palmer, of Jarrow-on-tyne, appear on the list for five boats each, Thornycroft for three, and the Fairfield Company for the fifteenth 30-knot boat. In each case the boats had to run for three hours for speed, and again for three hours at full speed to ascertain the consumption of coal, and it was a condition that should the average rate of consumption exceed 2.5 pounds I. H. P. per hour an extra load would have to be carried in the speed trial, this extra load to be equivalent to the excess in consumption over a given period. Only five out of the fifteen boats seem to have come within the 2½ pounds, the highest rate of consumption having been 2.77 pounds, in the case of one of Palmer's boats; but it is difficult to understand how in the case of Thornycroft's three boats there should be such variation as 2.08 pounds in one case, 2.2 pounds in another, and nearly 2.6 pounds in the third, when all three boats, engines and boilers were the same. The difference is equal to over 1¼ tons per hour, and it is probably attributable only to the stoking. Laird's boats' consumption varies less, between 2.41 and 2.53 pounds per I. H. P., while Palmer's varies between 2.42 and 2.76 pounds. The Fairfield Company's Osprey appears as burning 2.58 pounds per I. H. P. per hour. As to power, this necessarily would be affected by weather, etc., but there are also wide variations. The highest is 6606 I. H. P. for 30.142 knots in the case of Laird's boat, the Panther, but Fairfield is not far behind with 6588 I. H. P., but for this she has the best speed on the list. One or two of the boats, especially those of Thornycroft, got their speed for less than 6000 I. H. P., but for this she has the best speed on the list; the lowest was 5654 I. H. P.

for 30.184 knots. Messrs. Lairds boats range about 6000 to 6200, with the exception already given. The highest speed was got with the Fairfield boat, which made 30.674 knots when developing 6588 I. H. P., and on another trial 30.427 knots for 6412 I. H. P. So that the high power was in their case well justified by events. Palmer's Chamois comes next with 30.396 knots for 6265 I. H. P.

Ships Under Construction.

The following vessels will be under construction or completing during 1898-99: 12 battle-ships, 16 first-class cruisers, 10 third-class cruisers, 6 second-class cruisers, 10 third-class cruisers, sloops, 4 twin-screw gunboat destroyers.

[France.]

Amiral de Gueydon.

The dimensions of the new first-class armored cruiser Amiral de Gueydon, which has lately been commenced at Lorient, are as follows: Length, 448 feet 6 inches; beam, 63 feet; with a displacement of 9515 tons. She will be driven by three screws, and the engines are to develop 20,000 I. H. P., giving a speed of 21 knots. Her Niclausse boilers will be placed before and abaft the engines, the latter being constructed at the works of Chantiers de la Loire at St. Denis. There will be a water-line belt of hardened steel 6 inches thick, extending from the stem to near the stern, which will be closed by a transverse 3-inch armored bulkhead; above the 6-inch belt will be a second narrower belt of 3.9-inch steel protecting the cofferdam; there will also be two armored decks. The armament will consist of two 19.4-centimetre (7.6-inch) guns, of 93-96 model, in turrets, one forward and one aft, with an arc of fire of 270 degrees; eight 16-centimetre (6.3-inch) Q. F. guns of the same model in armored casemates, so arranged that four can fire ahead and four astern.—*Journal of the Royal United Service Institution.*

Bouvet.

The new French battle-ship Bouvet is complete, so far as outward appearances go. She is more like the Carnot than her other nominal sisters, but the similarity is only general and at first glance. In the Carnot the big gun in the side turret stands on a sort of redoubt, in the Bouvet it is balanced on an armored pillar. Probably the construction is identical in each case, and the redoubt of the Carnot may have no protective value—it is one of those things that information is not given away about, and on which the foreigner can only speculate. As it stands in the Bouvet, however, the construction looks singularly faulty; in order to obtain an end-on fire from half the entire armament the guns in question have been placed where quite a medium shell would surely put them out of action for good and all. The two smaller guns that help to fill this nest—they are in little turrets fore and aft of and below the larger gun—would share the same fate; in fine, a rational distribution of armament has been sacrificed in order to obtain an end-on fire—on paper. In action these guns, fired right ahead or astern, would probably blow away smaller turrets that project on the beam and quarter, in any case the blast would make matters singularly unpleasant for the guns' crews. The Bouvet has little in the way of military tops; such as

she has are placed low down; higher up there are only search-light platforms. The stern is built up and quite as high as that of our Majestic's; in the Carnot, Martel and Massena it is low. The bow gun is about 30 feet above the water-line. Still higher, on a light superstructure, the 3.9-inch quick-firers are carried; two on each side are directly over the amidships side barbettes, and certainly look as though they would be incommoded in action by the fire of the big gun just beneath them. The new French armored cruiser d'Entrecastaux is practically complete. She is best described as a small edition of the Charlemagne—a small edition, that is, in the same sense as our Powerful is an adaptation of the Majestic type to a cruiser design. The most noticeable feature of the d'Entrecastaux is the arrangement of the funnels, the aftermost of the three being set back by the mainmast, with a large gap between it and the second. The tops of the funnels also have, for a warship, a somewhat eccentric appearance, being much like those of railway locomotives. Some Scandinavian monitors are the only other warships in existence with funnel tops of this inverted bell shape, but in the case of the monitors they are still more pronounced.—*The Engineer.*

[JAPAN.]

ASAMA.

On Wednesday, March 23rd, there was launched from the Elswick shipyard a first-class armored cruiser for Japan. At the luncheon, after the launching had been successfully accomplished, Sir Andrew Noble made a speech, from which we are tempted to reproduce the following extracts, as they explain very fully the characteristics of the vessel and her armament:

The vessel, he said, that they had seen launched by Madame Arakawa was, he ventured to think, a remarkable one. Her length was 408 feet, her breadth 67 feet, her mean draught 24 feet 4¼ inches, and her displacement 9700 tons. Her machinery was of the twin-screw triple-expansion type, built by Messrs. Humphrys and Tennant, with a maximum indicated horse-power of 18,000, while her armament was very powerful, he might say remarkably so. It consisted of four 8-inch breech-loading quick-firing guns, fourteen 6-inch quick-firing guns, twelve 12-pounder quick-firing guns, seven 2½-pounder quick-firing guns, and five torpedo tubes, four being submerged, the latter being the class with which, as he had had occasion before to remark, they had achieved a remarkable success. But if he came to the Asama's defensive powers, they were nearly as remarkable. She had at her water-line a belt of Harvey steel 7 inches thick, her citadel was 5 inches thick, whilst her barbettes were 6 inches thick. Her conning tower was 14 inches thick and her casemates were 6 inches thick. Her protective deck was 2 inches thick from end to end. Both in the public press and elsewhere the question of cruisers and armaments had excited much attention of late, and so many comments had been made that he felt impelled to make a few explanatory remarks himself. In the first place, as he had said, the whole of her armor was Harveyed, and they must remember that Harveyed steel was at least equal to one and a half times the defensive power of compound armor. The radius of action of the Asama was about 10,000 knots at her most economical speed, and that was more than ample radius of action for the duties she was likely to be called upon to perform. As regards her arma-

ment, perhaps the most convenient way of expressing the Asama's very great power was by comparing her with the armament of the Powerful, which was one of the fastest cruisers in her Majesty's service. The main armament of the Powerful consisted of two 9.2-inch breech-loading guns, twelve 6-inch quick-firing guns, fourteen 6-inch quick-firing guns, and eighteen 12-pounders, whilst the armament of the Asama amounted to four 8-inch quick-firing guns, fourteen 6-inch quick-firing guns, and twelve 12-pounder guns. But they would observe that the whole broadside of the Powerful throws only a weight of shot at a single broadside amounting to 1472 pounds, while the broadside of the Asama amounted to no less than 1775 pounds. They would remember also that the Powerful was a vessel of, he thought, 14,500 tons displacement, whilst the Asama was only of 9700 tons displacement, and her maximum speed was 21½ knots. Turning to the guns, those 8-inch guns of the Asama had a maximum muzzle velocity of 2560 feet per second; but, for reasons which he should come to presently, it was not desirable that that high velocity should generally be used. It was a mistake to suppose that such high velocities were new. That firm had turned out and armed many ships with guns of a velocity of over 2500 feet per second. Further, they made experiments to show that with the new explosives that were now in general use elsewhere, it was possible to get, taking the 6-inch guns as an instance, a velocity of about 3000 feet per second. But it would be in the highest degree unwise to use those very high velocities, except for very exceptional occasions, the reason being that the erosion was so extremely rapid that in a very few rounds the velocity falls off enormously, to the extent of 300 feet or 400 feet, and in comparatively few more rounds the gun becomes unserviceable and requires relining, simply because the surface of the bore is swept away by the heat and pressure of the charge. It was also a mistake to suppose that it was a novelty to fire those high velocity quick-firing guns without the use of brass cartridge cases. The Elswick firm had turned out quick-firing guns of all sizes for some years without cartridge cases. But the point was, perhaps, too technical to dwell upon there. Both cartridge cases and guns without cartridge cases had their defects and had their advantages. With very high velocities it was, perhaps, preferable to dispense with the cartridge case, but that was a question that was open to discussion.—*The Engineer.*

United States Built Cruisers for Japan.

Of the two cruisers being built in the United States for Japan, that under construction at the Union Ironworks of San Francisco, Cal., and soon to be launched, is typical. She is a substantial duplication of the Buenos Aires, built at Elswick in 1895 for the Argentine Republic, with some modifications in armament, and may be said to be a development of the Yoshino. The general features and principal dimensions are: Length on load water-line, 405 feet 2 inches; beam, extreme, 49 feet; normal draught, 17 feet 7.25 inches; normal displacement, 4760 tons; normal coal supply, 350 tons; total bunker capacity, 1000 tons; estimated maximum indicated horse-power, 15,000; estimated maximum speed, 22.5 knots; complement, 405.

The ship has a double bottom extending from bow to stern and reaching well up above the water-line. There are something like fourteen main water-tight compartments, and numerous minor subdivisions. There will be a cofferdam on each side running well forward and aft, but it is

not the purpose of the Japanese to fill the space with cellulose at present. A protective deck, reaching from side to side, and running from the stem to the stern, completely covers the vitals. On the flat portions this deck is 1¾ inches thick, but on the slopes at the sides it is increased to 4½ inches. All woodwork is to be fireproofed by the present prevailing electrical process. The ship will be driven by twin screws, actuated by two sets of triple-expansion engines of the four-cylinder type, having cylinders of 40 inches, 60 inches, 66 inches and 66 inches diameter respectively, with a common stroke of 36 inches.

Steam will be supplied by eight boilers, four double-ended and four single ended, having a total grate surface of 792 square feet, and a total heating surface of 22,440 square feet; working pressure about 180 pounds. There are two engine-rooms and four fire-rooms, the latter being closed when under forced draught. The bunkers are so arranged that the coal comes in directly on the fire-room floor.

The principal offensive power of the ship is centered in a very formidable battery of quick-firing rifles. In the main battery there are two 8-inch and ten 4.7-inch rapid-fire rifles; and in the secondary battery there are twelve 12-pounders and six 2½-pounders. One 8-inch gun is mounted on the forecastle deck, the other on the poop deck, and each has a commanding arc of fire of 270 deg. The gun crews are protected by shields on each piece. These 8-inch guns are of the Armstrong type, and, together with the rest of the batteries, will be purchased in England and placed on board the ship when she reaches Japan. The 4.7-inch guns are mounted in sponsons on the main deck, and are sheltered by shields and the 3-inch sponson armor. The forward gun on each side and the after gun on each side have separately an arc of fire of 130 deg., the forward guns being able to fire dead ahead and the after guns being able to fire dead astern. The rest of the 4.7-inch rifles, and such of the 12-pounders as are sandwiched between on the main deck, have arcs of fire of 100 deg. The 12-pounders have the same 3-inch sponson armor about them. The four remaining 12-pounders are mounted forward and aft in sponsors near the bow and stern. The 2½-pounders are placed on the hammock berthing and up in the military tops. The 8-inch and the 4.7-inch rifles will be supplied with ammunition by electrical hoists, while the supplies for the smaller guns will be raised by whips from the magazines. A torpedo outfit of five tubes has been called for, two on each broadside and one in the stem, but there is reason to believe the bow tube will be removed. The value of such tubes has long been known to be more than questionable.

The ship will be lighted by electricity, and ventilated by natural and artificial means; and the fittings, so far as consistent with the Japanese regulations, will conform to the best American practice. The contract price is reported to be something like £205,000.—*The Engineer.*

[RUSSIA.]

PERESWIET.

The new first-class Russian battle-ship Pereswiet was launched at the Baltic Works on the Neva in the presence of the Czar and Czaritza and a large concourse of distinguished spectators, including the members of the foreign Diplomatic Corps and many foreign officers. The keel of the Pereswiet was laid down in November, 1895. Her chief measure-

ments are: Length, 434½ feet; width of beam, 71½ feet; depth below water-line, 26 feet; and displacement, 12,694 tons. She has three screws, and will be fitted with three vertical engines of triple expansion, each calculated to develop 4800 indicated horse-power, with 30 Belleville boilers in six groups, having a total heating surface of 43,418 square feet. The turrets for 10-inch guns are being made at the Nevsky Works, and the carriages for the smaller artillery at the Oboukhoff Works.—*Engineering.*

[SPAIN.]

PELAYO.

The near approach of war has naturally caused the utmost activity in the Spanish Navy, and the most earnest efforts are being made to get every available vessel into commission with the least possible delay. The ironclad Pelayo, at the time the Cuban question reached an acute stage, was in dock at Toulon, where she was being refitted with a new boiler installation, Niclausse boilers being substituted for those already in the ship. In such a crisis no attempt could be made to carry out complete trials; and a full-power trip was the most that could be done, but the conditions under which it was made, and the results given by the new boilers, seem sufficiently remarkable to merit notice.

The pipe work was not completed till the evening of April 6, and up to that time it had only been possible to raise steam in two out of the 16 boilers. Owing to the want of steam pipes the remaining 14 had never even had a fire below them. There was no time to try them, however, and early on the morning of April 7 the Pelayo sailed with all her boilers under steam. In two hours after leaving she attained her full speed of 16 knots with natural draught, all boilers being at work, and she maintained this speed during four hours. The horse-power developed was 8000. The boilers throughout worked satisfactorily, and the pressure was maintained with ease, although the stokers were exclusively Spanish merchant sailors, mobilized in readiness for war, who for the most part had no knowledge of boilers; the complement also was very incomplete.

The results were so satisfactory that the Spanish commissioners decided to accept the machinery at once, and towards four o'clock in the afternoon the Pelayo continued her voyage to Carthagena, after landing the contractors' representatives.

The Niclausse boiler is in use on several other Spanish war vessels, among which may be mentioned the cruiser Cristobal Colon, of 14,000 horse-power, and on many ships of the French and other navies. The run above described well maintains the reputation of its previous performances, the most striking of which was the recent test of the French cruiser Friant, under what were intended to be actual service conditions. It will doubtless be remembered that she was suddenly ordered to leave Quiberon, run to Cape Finisterre at 17 knots, then cruise in the Atlantic for six days and nights at 16 knots, watching for an imaginary enemy, and finally return to Quiberon at 17 knots. This she successfully accomplished without any special preparation. The present performance is, perhaps, even more remarkable, seeing that only two of the boilers had been under steam before; and it speaks well for the quality of material and accuracy of workmanship employed, that the whole 16 worked without hitch at full load from the moment of first lighting the fires under them; while the ease with which the pressure was maintained, in spite of

the utter inexperience of the stokers, is conclusive evidence of the steaming powers of these boilers.

The following is a brief description of the boiler installation on the Pelayo, with leading particulars and dimensions: There are 16 boilers in all, divided into four similar groups, two forward and two aft. The two forward groups are separated from each other by longitudinal watertight bulkheads; and the after groups are divided in the same way. Each group thus consists of four boilers, which are arranged in pairs; the two pairs are placed back to back with no space between, and the fronts run athwartship. This arrangement, which is only possible with boilers permitting all operations, whether of working or overhauling, to be performed from the front, is very economical of space.

It will be seen from the above that each group has two stokeholds, each stokehold serving for two boilers. These stokeholds are very large, because the length of the Niclausse boilers is much less than that of the old cylindrical boilers. Thus the forward and after stokeholds of the two after groups are 20 feet and 8 feet 8 inches wide respectively, and are of the full half-width of the ship; there is a passage from the forward to the aft stokehold in each group 2 feet 2 inches wide between the boilers and the side. The forward and after stokeholds of the two forward groups are 20 feet 9 inches and 8 feet wide respectively. It is evident that a portion of these spaces is available as auxiliary store-rooms, etc., since a width of 7 feet 10 inches is sufficient for the withdrawal of the tubes and other operations. There are two funnels, one for each pair of groups. Each boiler consists of 15 headers, each containing 18 tubes. The tubes are of steel, all lap-welded, except those of the lower rows, which are weldless; their external diameter is 3.2 inches, and their thickness .137 inch; they slope to the rear at an inclination of 1 in 10, and are fixed in the headers by metallic-coned joints, like all boilers of the Niclausse manufacture.

The steam and water drums are 9 feet long and 2 feet 8 inches in diameter, and the headers are attached to them by the ordinary double cone joints. On the top of each drum is a small steam drum 11¾ inches high in which is the intake of the steam pipe. The other end of this pipe is connected to the steam outlet on the drum which supplies the steam pipes both for the main engines and the auxiliary machinery. Within the drums are placed the mud catchers, the guide pipes for the descent of water into, and ascent of steam from such header, two feed pipes, and the cock to which the steam jet used in cleaning the outside of the tubes is connected to the outside of the drums are the safety valves, the "Soupape avertisseuse," water-gauge fittings, pressure gauge, two feed valves—one to the pump on the main engine, the other to the auxiliary pumps— a blow-off cock, a "robinet de plein," and an automatic feed regulator. The bottoms of the headers of each boiler are connected by a pipe with a blow-off cock discharging into the main blow-off. Each boiler has three fire doors, three ashpit doors and two main doors in the front of the headers. For the safety of the stokers, in case of a tube bursting, the fire and ashpit doors open inwards, and consequently close automatically under internal pressure; the fire doors are also balanced.

The following are the principal particulars and dimensions of the installation: Number of boilers, 16; number of furnaces per boiler, 1, total 16; number of heaters per boiler, 15, total 240; number of outer tubes per boiler, 270, total 4320; number of inner tubes per boiler, 270, total 4320; diameter of outer tubes, 3.22 inches; dia-

meter of inner tubes, 1.57 inches; length of outer tubes, 7 feet 1 inch; length of inner tubes, 6 feet 11 inches; grate area per boiler, 53.25 square feet, total 852 square feet; heating surface per boiler, 1760 square feet, total 28,160 square feet; heating surface ÷ grate area = 32:1; floor space occupied per boiler, 76.25 square feet, total 1220 square feet; grate area per square foot floor space, .7 square foot; heating surface per square foot floor space, 23 square feet; horse-power, 85; water space per boiler, 120 cubic feet, total 1920 cubic feet; steam space per boiler, 25.4 cubic feet, total 4064 cubic feet; number of fire doors per boiler, 3, total 48; number of ashpit doors per boiler, 3, total 48; number of funnels, 2; pressure, 170 pounds per square inch; weight of boilers, including framework, setting, valves and cocks, tubes and headers and drums, 255 tons; weight per square foot of heating surface, 20 pounds; weight per square foot of grate area, 620 pounds; weight of boilers as above, including water and all accessories, 345 tons; weight per square foot of heating surface, 27.4 pounds; weight per square foot of grate area, 900 pounds.

The foregoing particulars possess a special interest at the present time, when the Pelayo will unfortunately be employed on active service.—*Engineering.*

Spain's Armored Cruisers.

The admission of vessels into the category of armored cruisers is governed so much by individual fancy that the term is in many cases very misleading. It might well be divided into at least three subheads, or else abolished altogether, for at present variations are so great that comparisons between ships designated as "armored cruisers" are well nigh impossible. There are cruisers, all called "armored," without any other distinction: (1) With armor on both guns and belt; (2) with armor on belt only; (3) with armor on the guns only. To the latter class the Spanish cruiser Carlos V belongs, but as a general—and quite unreasonable—rule ships with armor for the guns only, like our Powerful, are classed as first-class protected cruisers, while a thin 3-inch belt will dignify them with the title of armored cruiser. If we compare the majority of Spanish cruisers, the Vizcaya and Infanta Maria Teresa class with their battle-ship Pelayo, we see that the sole difference between them is that where the Pelayo has a belt all around her the Vizcayas have a partial belt for three-quarters of their length and bulkheads. The Pelayo has, of course, four big guns against their two, but then she is the bigger ship.

In both cases the guns are identically protected, a narrow barbette, with nothing below save an armored hoist. In each case a thin shield covers the gun breech—a foolish thing probably, since it is just sufficiently thick to burst a shell and far too thin to keep anything out. Before Yalu the Chinese removed these shields from their battle-ships, and there was probably wisdom in so doing, though we must bear in mind that the Japanese have since replaced them in the Chin Yen. Probably, however, the new shields are of tougher armor, but on that no details are available.

We find, therefore, that to all intents and purposes the Spanish Vizcaya class are battle-ships of the second class, slightly armored, it is true, yet with more armor than the Italian Lepanto carries, since that "ironclad" has no belt at all. A vessel which—save that she has a 2-inch armor over the quick-fire guns—is identical to the Italian Lepanto in the arrangement of armor is the Carlos V. She has no belt, but a very thick deck—6-inch—her big guns in fore and aft barbettes alone are armored. The arrange-

ment of guns is, of course, quite different to the Lepanto's, but the "idea" in both ships is similar. This idea is that a belt of coal and cellulose, with a thick deck below it, is quite equal to a heavy belt of armor. So far as protecting the engines goes this is true; and it *may* prove true in other ways. At the best, a belt is only a strip, liable to penetration above and below in a seaway.

The Cristobal Colon could, and no doubt will, "lie in the line" if there is a naval action; she is proof against every sort of shell. Except her and the Pedro d'Aragon, now building, which carry 10-inch guns, all the Spanish armored cruisers carry a couple of 11-inch guns, very good pieces, able to penetrate all the armor on the American battle-ships' guns.

The American armored cruisers are quite different; they are really armored cruisers. Their belts, instead of being 12-inch steel as in the Vizcayas, are of 3-inch steel only; their big guns are only of 8-inch calibre. Now, an 8-inch projectile is quite useless against the belts of the Vizcayas, or against their barbettes, and in engaging such ships shell fire alone could be depended on to do anything. Of course shell fire is the staple attack, but the Brooklyn and New York can do nothing against the Spaniards with their comparatively feeble 8-inch shell that the Spaniards cannot do against them with a far more powerful gun. It is rank heresy maybe, but we cannot but hold that there is a tendency to unduly glorify the small quick-fire gun or the medium-sized 8-inch. The chances of hitting are, of course, greater with the smaller weapon, both from its extra rapidity and its extra numerical quantity; but when the big shot does hit its effect will be, of course, far greater. However, the *métier* of the Spanish and American armored cruisers is quite different, and it is profitless to compare them. Spain's force is really a number of second-class battle-ships—known as "armored cruisers"—and these will be pitted against a much smaller number of first-class American battle-ships. The "many eggs in one basket" is, when all things are considered, the best for battle-ships. America therefore, apart from other considerations, should win. It is not very safe to prophesy anything, but the probabilities are either a "walk over" for one side or else an absolutely indecisive but sanguinary result. There is not likely to be a mean between these extremes.

The other principal data with regard to the vessels referred to above are as follows: The Vizcaya is an armored cruiser, launched at Bilbao in 1891, carrying two 11-inch guns in two barbettes, and ten 5.5-inch guns, besides smaller weapons. Her displacement is 7000 tons, her length 340 feet, breadth 65 feet, and maximum draught 21 feet 6 inches. She is propelled by twin screws, her engines developing 13,000 horse-power. Her normal coal supply is large, namely, 1200 tons, sufficient to take her nearly 10,000 miles at 10 knots. Her maximum speed is 21 knots. With the exception of the Pelayo, she and the vessels of the same class are the most heavily armored in the Spanish navy. They have belt armor 12 inches thick, extending from bow to stern, but tapering off at the extremities; their big guns are protected by 10½ inches of armor, and the deck plating is 3 inches thick. The Infanta Maria Teresa, also built at the same time and in the same yard, develops rather more power, but is armed and protected in the same way, and is of the same dimensions. Both ships have six torpedo tubes. The Almirante Oquendo, Cataluna, Cardenal Cisneros, and Princessa de Asturias are all very nearly the same in dimensions, and all carry the same guns and armor, so that these six ships form a valuable squadron, and as the slowest of them can steam

20 knots, they ought, if combined, be able to give very good account of themselves.

The Cristobal Colon, originally Giuseppe Garibaldi II, is of rather less displacement—6840 tons—and indicates 14,000 horse-power, but makes only the same speed as the Vizcaya class. Her main armament consists of two 10-inch guns and ten 6-inch, and six 4.7-inch and four torpedo tubes, so that she is powerful in this respect. She is protected by a 6-inch belt of Harveyed steel, and her guns are similarly provided. Her deck plating is 1½ inches thick. Her normal coal supply is 1000 tons. She was launched at Sestri Ponente in 1896.—*The Engineer.*

[UNITED STATES.]

KEARSARGE AND KENTUCRY.

The U. S. battle-ships Kearsarge and Kentucky were successfully launched from the yards of the Newport News Shipbuilding Company on March 24. The Kearsarge was christened with a bottle of champagne, the Kentucky with water from a cut-glass bottle, but several enthusiastic Kentuckians hurled some bottles of good old whiskey against the sides of the Kentucky at the same time. The following are some of the principal facts concerning the ships: Each of the vessels is 385 feet long, 72 feet 2.5 inches beam, 14 feet 3 inches freeboard forward, and 12 feet 3 inches freeboard aft. Their draught, with 410 tons of coal on board, is 23½ feet; their displacement is 11,525 tons. In their turrets they will each have four 13-inch and four 8-inch guns. There will be four torpedo tubes, two on either broadside. The armor will be of solid nickel steel, Harveyized. The lower part of protection will have armor 15 inches in thickness. The armor of the turrets will also be 15 inches, except immediately in front, where it will be made 17 inches. In addition to these heavy guns a battery of fourteen 5-inch rapid-fire guns, a numerous battery of smaller 6-pounder and 1-pounder guns will be carried, such guns being placed wherever they can fire to advantage. The protection of the hull to the water-line region will be effected by means of a side armor belt of a maximum thickness of 16½ inches, with a mean depth of 7½ feet, so disposed in reference to the load line that the vessel with 410 tons of coal on board will have 3½ feet of this belt armor above the water, and with 1210 tons of coal on board will have 2 feet above the load line. The belt will extend from the stem to the after barbette, and will maintain the maximum thickness from the after end of the belt to the forward boiler-room bulkhead, whence it will taper gradually to a thickness of 4 inches at the bow. The conning tower will have armor 10 inches thick, with a tube 7 inches in thickness leading down to the armor deck for the protection of the voice pipes, telegraph, steering rods, etc. The vessels will be driven by triple-expansion engines actuating twin screws, the engines having a collective horse-power of 10,000 when making about 120 revolutions a minute. Five boilers, three double-ended and two single-ended, in four water-tight compartments, will generate the necessary steam at a pressure of 180 pounds to the square inch. The vessels will carry a supply of coal of 1210 tons.—*Engineering.*

ALABAMA.

The United States battle-ship Alabama, the first to take the water of the three new vessels of her type, was successfully launched at noon on

Wednesday, May 18, from the yard of the William Cramp & Sons Shipbuilding Company, Philadelphia. The naming ceremony was performed by Miss Morgan, daughter of the senior Senator from Alabama. The building of the Alabama, as of that of her sister vessels, the Illinois and the Wisconsin, has been delayed over a year by the failure of the last Congress to make provision for the supply of their armor plate. Otherwise the battle-ship would now have been fitting out for service instead of being launched.

The general dimensions of the Alabama are as follows: Length over all, 374 feet; breadth, 72 feet; freeboard forward, 20 feet; freeboard abaft the after turret, 13 feet 3 inches; draft, 23 feet 6 inches; displacement, 11,525 tons. The guaranteed speed is to be 16 knots and the estimated horse-power 10,000. The main battery consists of four 13-inch guns in two turrets and fourteen 6-inch rapid-fire guns, of which ten are mounted on the gun deck—eight in broadsides between the turrets and two forward of the fore turret, to fire straight ahead—and four are mounted in a small redoubt on the casemate deck, two on each side. The secondary battery embraces seventeen 6-pounder rapid-fire guns, six 1-pounder rapid-fire guns and four gatlings.

The armor, armament and speed of the Alabama, with a displacement of 11,525 tons, compare favorably with that of the latest type of battleships built abroad with a displacement of 15,000 tons. The maximum thickness of armor on the water-line is 16½ inches, tapering to 9½ inches at the bottom of the belt. The casemate armor is 5½ inches thick and the superstructure armor is of the same thickness. The armor of the 13-inch gun turrets is 15 inches thick, except the port hole plate, which is 17 inches. The armor of the barbettes on which the turrets rest is 15 inches thick. The thickness of the protective deck armor on the flat over the citadel amidships and also forward and aft is 2¾ inches, and the thickness of the slopes forward and aft of the amidship citadel is 4 inches. The conning tower is cylindrical and 18 inches thick. The total weight of armor and bolts is 2720 tons and the protective deck armor 593 tons. The weight of armament with normal supply of ammunition, which is two-thirds of the full war supply, is 864 tons. The two engines of the Alabama will be of the vertical three-cylinder type, operating twin screws. She will be equipped with eight single ended boilers, placed athwartships.—*Iron Age.*

U. S. S. New Orleans (Amazonas)

The United States Government have been buying or trying to purchase ships of war in various directions, and with varied success. The Brazilian Government have sold two, probably at a considerable profit, namely, the Amazonas and her sister the Almirante Barroso. The former has been lying off Gravesend all the week.

The Amazonas was built at Elswick, and is a very fine vessel. She has a displacement of 3600 tons, is 330 feet long, 43 feet 9 inches beam; her mean draught is 16 feet 10 inches, her horse-power 7000; she carries for her size a tremendous armament, including six 6-inch quick-firers, four 4.7-inch quick-firers, ten 6-pounders, four Maxims.

A 3-inch protective deck extends from stem to stern, and additional protection to the machinery and boilers is afforded by the reserve longitudinal bunkers, which carry coal to a height of about 6 feet above the water-line. The Amazonas attained a speed of 20 knots with natural

draught, and 21.05 knots with forced draught. The gun positions are protected by 4½-inch armor. A very powerful fore-and-aft fire can be obtained, as two of the 6-inch guns are in shields on the poop and forecastle, and the other four are sponsoned out, two forward and two aft. The 4.7-inch guns are carried in recessed ports, so as to be clear of the fire of the larger pieces. The ammunition is supplied through hoists worked by electric motors.—*The Engineer.*

Features of the New Battleships.

Secretary Long has just published a circular which defines the characteristics of the three seagoing coastline battle-ships authorized by the new naval appropriation law. It is proposed that the new ships shall have a load water-line of 368 feet; the breadth at water-line will be 72 feet; and the mean draught at the normal displacement 23½ feet; the normal displacement is to be 11,500 tons and the total coal capacity 1200 tons. The hull is to be of steel, with a double bottom, and is to be subdivided by watertight compartments. The hull at the water-line is to be protected by an armor belt of a maximum thickness of not less than 16½ inches and a mean depth of 7 feet 6 inches. This belt is to extend at least from the stem to the after barbette and to maintain the maximum thickness through the engine and boiler spaces. From the boiler space forward it may be tapered to a uniform thickness of 4 inches. The transverse armor just forward of the boiler space and at the after end of the belt will not be less than 12 inches in thickness. Throughout the length of the vessel a protective deck is to extend. Where this deck is worked flat the total thickness will not be less than 2¾ inches, and where worked with inclined sides the slope will be 3 inches in thickness forward and 5 inches in thickness aft. A cellulose belt is to be fitted along the sides for the whole length of the ship. The barbettes for the 13-inch guns will have armor 15 inches thick, except in the rear, where it will be reduced to 10 inches. The turret armor is to be 14 inches throughout. The ship's sides, from the armor belt to the main deck, will be protected by not less than 5½ inches of steel armor from barbette to barbette. Coal is to be carried back of a portion of this 5½-inch casing armor.

In a suitable position will be a conning tower of not less than 10 inches in thickness, having an armored communication tube 7 inches in thickness. Four 13-inch guns will be mounted in two heavy barbette turrets on the midship line, one forward and one aft. There will be ten 6-inch rapid-fire guns in broadside on the main deck, four on the upper deck within the superstructure, and a secondary battery of twenty-four rapid-fire and machine guns. The 6-inch guns on the upper deck will be protected by 5½-inch armor. There will be two submerged torpedo tubes. The torpedo compartment will be fitted up for the storage of eight 17-foot torpedoes and appliances and means for operating and handling the same.

The vessels will be driven by twin screws. The engines will be of the vertical triple-expansion four-cylinder type, two in number, one on each shaft, and they will be placed in separate watertight compartments. The eight boilers are to be cylindrical and single ended. They are to be placed in four separate watertight compartments, and will work at a pressure of 210 pounds. If on trial the average speed shall equal or exceed the speed at sea of 16 knots an hour for four consecutive hours, the vessel will be accepted as far as the speed is concerned. If the speed

falls below 16 knots and exceeds 15 knots an hour, the vessel will be accepted at a reduced price, the reduction being at the rate of $25,000 per quarter-knot, if the deficiency of the speed lies between 16 knots and 15½ knots, and at the rate of $50,000 per quarter knot between 15½ knots and 15 knots. If the speed falls below 15 knots an hour the vessel will be rejected or accepted at a reduced price. No sail will be carried, but two military masts are to be fitted with fighting tops.—*Scientific American.*

The Destroyers and Torpedo Boats.

The Naval Construction Board has prepared the specifications of the proposed destroyers and torpedo-boats to be built in accordance with the authority conferred by the naval appropriation act. Twenty-eight boats—16 torpedo-boat destroyers and 12 torpedo-boats—will be built and bids will be invited on the basis that the destroyers shall be of not less than 400 tons nor more than 435 tons displacement, capable of making a speed of not less than 30 knots an hour, and that the torpedo-boats shall not be less than 150 nor more than 170 tons displacement, capable of making a speed of not less than 26 knots an hour. One of the most important requisites of the proposed vessels is that the destroyers shall be able to make a high speed in a heavy seaway and torpedo-boats a high speed in a moderate seaway. The disablement of the boats is guarded against by a provision that the engines and boilers shall be in separate compartments. The destroyers are to have a minimum coal capacity of 100 tons, which will give them a steaming radius of 5000 miles. The torpedo-boats will have a coal capacity of 40 tons, and their steaming radius will be about that now possessed by the torpedo-boat Porter, which is with the division of the North Atlantic Squadron near Porto Rico.

The torpedo-boats are to be supplied with an unusually formidable armament. They are to be equipped with 3-pounder semi-automatic rapid-firing guns and three torpedo tubes, while the destroyers will be given batteries including two 12-pounder and five 6-pounder semi-automatic rapid-fire guns and two torpedo tubes. The total cost of each destroyer is fixed at $295,000 and of each torpedo-boat at $170,000. A balance of $140,000 will remain from the appropriation to meet minor expenses incident to the preparation of plans and other details for the proposed vessels. The contracts will provide penalties for each quarter-knot below the contract requirement and for every day's delay beyond the time limit to be fixed. It is proposed that the destroyers shall be furnished to the Government within 18 months and the torpedo-boats within 12 months.—*Iron Age.*

New Monitors.

Plans are being rapidly pushed by the board for the monitors whose construction is authorized by the naval appropriation act. The designing of these vessels is proceeding under the direction of Chief Naval Constructor Hichborn. On account of the small appropriation made by Congress for each of these vessels—$1,250,000—it has been determined to limit their size to 2500 tons displacement, and to supply each ship with a single turret to be placed in the forward part of the vessel. It has not been definitely decided whether to equip them with two 12-inch or two 10-inch breech-loading rifles. The superstructure of the vessels will ex-

tend from the turret nearly to the stern, and rapid-fire guns will be placed on this to be directed against torpedo-boats that may attempt to attack the ships. The turret will be so arranged that the guns can be trained over an arc of at least 300 degrees, so that they can be fired in almost any direction except dead astern. These vessels will not be as efficient as the double-turreted monitors, but they will be very effective harbor defenders, and the Department proposes to make them as powerful as possible with the money granted by Congress. They will probably require two years to build.—*Iron Age.*

Holland Submarine Torpedo Boat.

It is reported that this boat recently made a run of one and a half miles under water, remaining under the surface for twelve minutes. This is the longest run under water which the boat has yet made, and it is stated that she behaved herself very satisfactorily in every respect. A few of the leading particulars of this vessel will be of interest. She is 55 feet long, 10 feet 3 inches in diameter, and of 75 tons displacement. The steel hull is cigar-shaped, and the boat is propelled by a single propeller. The motive power equipment consists of a 50 horse-power gasoline engine and dynamo, the latter being directly coupled through a clutch at each end of its shaft to the propeller shaft and to the gas engine respectively. A storage battery of 60 special type chloride accumulators is installed, the total weight of the battery being 45,000 pounds. The cells are constructed of steel, lined both inside and out with lead, and are stated to be capable of discharging at 300 ampères for six hours or at 1000 ampères for half an hour. The arrangement of gearing permits of the propeller being run by the engine or of the cells being charged, except, of course, when the boat is submerged, when the motive power is supplied from the cells to the dynamo as a motor. Enough fuel is carried in the cellular bottom to propel the boat on the surface for 1000 miles at eight knots. The dynamo is a 50 nominal horse-power machine, weighing 3500 pounds; the armature speed is 800 revolutions per minute; there are two commutators and a double-wound armature; an overload to 150 horse-power is possible without detriment. The normal speed of the Holland is nine knots, at an expenditure of 50 horse-power. A 10 horse-power motor with a 7 horse-power Ingersoll air compressor is installed for supplying air at 2500 pounds pressure to the reservoirs. The compressed air is used to propel the torpedoes, emptying the water ballast tanks, steering and for supplying respiration. A ½ horse-power motor is used to force the foul air into the water when the craft is submerged, and another of the same capacity to ventilate the battery when charging. The boat is caused to sink by an alteration of the pitch of horizontal diving rudders. When above the surface the craft is steered by observation through the port holes of the conning tower; when below the surface, or nearly so, by compass or by a camera-lucida arrangement fitted in a tube. The Holland's armament consists of an 18-inch torpedo tube opening at the bow of the boat, and three Whitehead automobile torpedoes are carried aboard. There is also an 8-inch aërial torpedo gun at the bow, and pointing aft a submarine gun, both of the latter capable of discharging 80-pound dynamite shells at high velocities. All the guns operate by compressed air, and can be discharged when the boat is submerged. The crew consists of five men.—*The Engineer.*

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LE YACHT.

MARCH 5. High Power Explosives, and the Armor of Cruisers. Coast Defenses (continued).

MARCH 12. Coast Defenses (continued), Em. Duboc. Automatic Closing of Holes Caused by Shells.

MARCH 19. The Cup of France.

MARCH 26. Coast Defenses (Em. Duboc).

APRIL 2. Unquestionable Rights of Officers in the Navy. The Voyage of the Powerful from Portsmouth to Hong-Kong.

APRIL 9. The Navies of Spain and the United States (Em. Duboc). The Second-class French Cruiser Pascal.

APRIL 16. Specialization of Cruisers: Tactical Cruisers (Scouts), Despatch Cruisers, Destroyers, and Cruisers for Service in the Colonies.

The Boilers of the Battle-ship Pelayo.

The most important changes in the Pelayo while in the Seyne shipyards were the replacing of the cylindrical boilers by the Niclausse boilers and, as a consequence, the modification of the ship's armament. As is already known, her primary battery consists of two 32-cm. and two 28-cm. in separate turrets; one turret forward, one aft, and one on each side. Three of the four pieces can fire at the same time. The secondary battery consists now of eleven Canet R. F. guns of 14 cm., ten of which are in protected redoubts, and one forward, as a bow chaser; formerly there was no protection for the guns. In spite of contrary rumors, the Pelayo is said to be in a satisfactory state of efficiency.

APRIL 23. Coaling Drills.

It is hardly necessary to demonstrate the importance of the question of rapidly refilling the empty bunkers of the ships of a squadron. In England, coaling ship has turned into a kind of sport, betting contests taking place between rival crews as to the number of tons each can stow aboard, say in an hour's time. The activity and endurance of the crews have been remarkable.

Deep-sea Torpedo-boats.

APRIL 30. The Hispano-American War (Em. Duboc). La Jeanne d'Arc.

An armored cruiser of 11,300 tons displacement. Total length, 145 m.; main breadth, 19 m. 40 cm.; draft aft, 8 m. 12 cm.; coal supply corresponding to the above draft, 1400 tons. The hull is partitioned in accordance with the most improved methods. The lower armored deck is on a level with the water-line, in the axis of the vessel; it descends 1 m. 50 cm. below the water-line, to the lower edge of the side armor. The latter is composed of two strakes, one whose upper edge rises 70 cm. above the water-line, and reaches down to the lower armored deck, and the other a thin strake.

MAY 7. The Hispano-American War. The Battle of Manila.

MAY 14. Submarine Lithologic Charts.

MAY 28. Military Power of Modern Fleets Compared with that of Ancient Fleets. The Fast Cruiser Chateaurenault of 8018 tons, built by the Forges et Chautiers de la Méditerranée.

REVUE DU CERCLE MILITAIRE.

MARCH 5. Cavalry Attacks in Battle against the various devices for supplying an Army Corps (2nd work on the chart), ended.

The Combat (Lieut.-Col. Paguin's Lecture) (continued).

MARCH 12. 19 Examinations for Admission to the "École Supérieure de Guerre." A Solution of the "Tactical Question."

International Exhibition of the Army and Navy in 1900.

MARCH 26. The March, the Stand and Combat of Small Units.

APRIL 2-23. 3rd Work on the Chart, with Extra Map and Sketch.

MAY 7. The Moral Factor in the Command of Troops.

MAY 21. Psychology of the Battle-field.

MONITEUR DE LA FLOTTE.

MARCH 19. Increase of the English Navy.

MARCH 26. The German Naval "Sextennate" (1898-1903). 471,200,000 marks will be spent in installments, covering a period of six years, for new constructions.

APRIL 2. The Navy Estimates in the French Parliament.

APRIL 9. United States and Spain.

APRIL 23. The Proper Practice Ship for Midshipmen (French).

APRIL 30. Vessels Built on Speculation.

MAY 7. The Battle of Manila.

REVUE MARITIME.

FEBRUARY-MARCH. Solution of Some Kinematic Problems. The Right of Search in Time of Peace. The Current and the Exact Position of a Vessel with Land in Sight, and one Point only for a Bearing.

APRIL. An Essay on the Classification of Water-tube Marine Boilers.

RIVISTA DI ARTIGLIERIA E GENIO.

FEBRUARY. Questions Relative to the Organization of the Defenses of the Alpine Frontiers. A Study of a Permanent Battery (4 Plates). Field Redoubts and Defenses of Villages, Deguise System. Considerations and Propositions (3 Plates) Our Field Artillery on the Alpine Frontiers.

MARCH. On the Applications of the Principles of the Art of Defense.

APRIL. The Theorem of the Least Effort Applied to the Research of the Effects of Discharge of Fire-arms. Upon a Proposition to Modify the Use of the Coast Telemeter.

RIVISTA MARITTIMA.

MARCH. The Micro-organism of the Sea, and Alteration of Paint on Hulls. The English Army and Navy. Fourth Contribution to the Naval Kinematic.

APRIL-MAY. Sanitary Service in Naval Battles. About Actions Between Ships. The Spanish-American Conflict. Projections by Sections in Cartography.

REVISTA MARITIMA BRAZILEINA.

FEBRUARY. Proposed Regulations for the Naval School. Penetration of Projectiles through Resisting Mediums. Developments of the War Navies During the Last Decade.

MARCH. Penetration of Projectiles, etc. Project of an Airship. Developments of the War Navies, etc.

BOLETIN DEL CENTRO NAVAL.

DECEMBER, 1897. The Artillery of the Future. The Practice Ship Presidente Sarmiento.

JANUARY-FEBRUARY, 1898. The Part Played by the Gun in Naval Battles. The Next Naval War (ended). A Study of the Medical Service Afloat.

SOCIÉTE DES INGÉNIEURS CIVILS.

DECEMBER, 1897. Tunnelling by the Shields Process.

JANUARY, 1898. Some Results of the Trials of Marine Boilers.

Of all the steam generators, the writer gives the preference to the water-tube boilers, owing to the fact that the weight of the materials used is always much better utilized, and in most cases the consequences of an accident, which is always possible, are reduced to a minimum of seriousness.

A Note on Steam-emulsion Boilers.

FEBRUARY. Electric Heaters.

REVIEWERS AND TRANSLATORS.

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